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HE SPORT FISHERIES OF GREAT SOUTH BAY AND VICINITY[1]

Philip T. Briggs Conservation Biologist Trainee
New York State Conservation Department

ABSTRACT

The sport fisheries of Great South Bay and vicinity were studied from 1956 rough 1960. The results show that the catch was dominated by the fluke and the inter flounder. Together these two fish comprised about 90 per cent of the annual tch of all species combined. The open boat and charter boat fisheries were almost ntirely dependent upon them. Over a million and a half fluke alone were taken, on e average, from June through September. Restrictions on fluke fishing may be sirable during May and October.

Bluefish ranked highest among the other species taken. Immature bluefish "snappers") sustained the bank and pier fishery during August and September, but id not appear to be fully exploited by the other fisheries. Adult bluefish were most nportant to the surf fishery. They also comprised a substantial part of the late mmer catch of the private boat fishery.

Blackfish were taken in large quantities during the spring and again during the ll. They were important during the fall to the bank and pier fishermen. Rowboat nd private boat fishermen were also dependent upon this fish, but to a lesser extent.

The surf fishery, the smallest of those studied, was almost entirely dependent upon riped bass and kingfish, in addition to adult bluefish. The kingfish, although usually e most frequently taken, did not appear to be fully exploited.

The private boat fishery dominated the others both in the number of anglers and tal catch. However, the open boat and charter boat fisheries had the greatest catch er effort for the principal species taken. Bank and pier fishermen tended to have a wer catch per effort for the species they sought than did boat fishermen. This shery may be faced with the problem of loss of access as commercial and residential evelopment of the southern shore of Long Island continues. Rowboat facilities are eclining, but the short duration of this study makes it difficult to state that this or e various fluctuations in the numbers of anglers in the other fisheries are permanent trends.

There are six sport fisheries in the Great South Bay area, i.e., bank nd pier, rowboat, open boat, charter boat, private boat, and surf.[2] The rst five are pursued in Great South Bay proper, while the surf fishery is ngaged in along the barrier beach that encloses the bay.

Great South Bay is located on the southern shore of Long Island. t is less than an hour's travel from New York City. Because of its proxmity to the metropolitan area, and because of the abundance and variety

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-15-R.

[2] The different types of boats may be described as follows:

rowboats —rented boats with outboard motors, usually 14 to 18 feet long

open boats and charter boats —large, Coast Guard-documented vessels (35 to 65 feet long) with a licensed captain and mate; these boats are available to the general public, open boats on a "first come-first served" basis, charter boats by reservation to single groups

private boats —all other sport fishing boats.

of fish available, it has been an important sport fishing center for many years. In 1938, recreational fishing in this bay was studied as part of a survey of the fisheries of Long Island (Westman, 1939). The present study was carried on from 1956 through 1960.

The main study area extended from the Nassau-Suffolk County line eastward to Howell Point at Bellport and was bounded on the south by the barrier beach—an area approximately 26 miles long and from 2 to 5 miles wide. The water is relatively shallow and, except in Fire Island Inlet, few places exceed 10 feet in depth. For the surf fishery, however, the study area was the roughly 15 miles of beach from Jones Inlet east to Fire Island Inlet.

The other fisheries were engaged in throughout the bay. There were concentrations of berthing facilities for open and charter boats at Captree State Park, Babylon and Lindenhurst. Although bank and pier fishermen utilized all places affording public access, there was a concentration at Captree State Park where two public fishing piers were available for use at no charge.

METHODS[3]

Personal interviews of over 54,000 anglers (recorded on punch cards) and confidential catch records from selected rowboat stations, open boat captains and charter boat captains were used to determine the catch per effort (fish per angler per trip) for each species sought, the combined catch per effort for all species, the percentage of the catch represented by each species, angler preferences as to species, and the average number of anglers per trip in private boats, rowboats, open boats and charter boats. Anglers fishing less than 4 hours were not recorded, since this was the minimum time considered to constitute an angler trip (one angler day).

Aerial census flights, randomly distributed by season and by weekdays and weekend days (holidays were considered as weekend days), were made from June through September in 1956 and 1957, from April through September in 1958, and from April through October in 1959 and 1960. The number of flights was 16 in 1956, 18 in 1957, 30 in 1958, and 36 each in 1959 and 1960. The data were used to determine the total number of anglers in each fishery that were fishing on the day of the flight. In the case of the boat fisheries, the numbers of boats were counted and multiplied by the average number of anglers per trip for the month involved. On each day of the aerial census, two flights were made (weather permitting), one in the morning (between 10:00 a.m. and noon) and one in the afternoon (between noon and 3:00 p.m.). The data used were those for the period of greater activity each day.

[3] The methods described were developed by Irwin M. Alperin, conservation biologist of the New York State Conservation Department.

To obtain the total anglers in a given month, the average counts for flights on weekdays and on weekend days were multiplied by the respective numbers of such days in the month and then combined. It was necessary to compute the data for the two separately because of the great difference in fishing pressure. Often more anglers fished on the relatively few weekend days of a month than did on all of the weekdays.

Once the number of anglers in a month was determined, the total catch of all species for each fishery was calculated by multiplying that number by the catch per effort for all species combined. From this, the catch of individual species was determined according to the percentage composition of sample data. This was used, and not catch per effort for the individual species, in order to include those fish taken incidentally while another species was being sought.

Due to the limitations of aerial census flights after dark, night fishermen were not interviewed. Were night fishing included, there would have been increases in the number of surf fishermen seeking striped bass and bluefish and private and charter boats seeking bluefish.

THE FISHERIES IN GENERAL

The findings of this study are presented here mainly as tables with commentary. They indicate that two species of flatfish, the fluke (*Paralichthys dentatus*) and the winter flounder (*Pseudopleuronectes americanus*) are the backbone of all the fisheries except the surf fishery.

In general, about a quarter million anglers fished in Great South Bay and its vicinity annually (Table 1). The tremendous number of anglers in the private boat fishery dominated sport fishing in the area. Indeed, the number of anglers using private boats averaged twice that for the next most popular approach, open boats.

The greatest angler activity usually took place in July (Table 2). However, bank and pier fishing reached a peak during August, coinciding with the highest catch per effort for the immature ("snapper") bluefish (*Pomatomus saltatrix*) as shown in Tables 2 and 14. Surf fishing was usually at its highest level in September, coinciding with an increase in the catch per effort for striped bass (*Roccus saxatilis*) as shown in Tables and 23.

The total anglers fishing in Great South Bay has declined since 1958, due in part to a decline in the number of rowboat stations and of charter boats since 1957 (Table 3). There has been a general increase of anglers in the early spring (April) and in the fall (October); however, this only slightly offset the decreases that occurred among those participating in some of the fisheries during the summer (Table 2).

Charter boat and rowboat fishermen were most numerous in 1957; private boat and bank and pier fishermen, in 1958. The private boat fishery increased considerably from 1956 to 1960. The open boat fishery

TABLE 1. TOTAL ANGLERS IN THE GREAT SOUTH BAY AREA DURING PERIODS OF GREATEST ACTIVITY, 1956–1960

Fishery	1956	1957	1958	1959	1960	Average	
						Number	Per cent
June to September							
Bank and pier	30,448	41,421	42,129	34,804	35,308	36,822	13.2
Rowboat	35,761	37,030	31,787	25,605	26,126	31,262	11.2
Open boat	58,061	35,166	52,780	71,658	45,496	52,632	18.9
Charter boat	47,544	50,442	32,821	29,695	33,521	38,805	14.0
Private boat	86,688	108,783	164,188	110,524	105,839	115,204	41.4
Surf	2,513	3,658	2,750	2,952	5,677	3,510	1.3
Total	261,015	276,500	326,455	275,238	251,967	278,235	100.0
April to October*							
Bank and pier	.....	.....	50,527	47,543	51,741	.....	.....
Rowboat	.....	.....	40,072	35,474	34,672	.....	.....
Open boat	.....	.....	69,942	100,222	70,045	.....	.....
Charter boat	.....	.....	51,192	48,097	53,078	.....	.....
Private boat	.....	.....	189,332	147,235	150,959	.....	.....
Surf	.....	.....	4,154	4,650	8,558	.....	.....
Total	.....	.....	405,219	383,221	369,053	.....	.....

* Covers only April to September in 1958.

expanded from 1957 through 1959, but in 1960 it suffered a decrease o about 30,000 anglers. The surf fishery increased steadily from 1958 t 1960. However, it cannot be stated from this short study that thes fluctuations show permanent trends. It is certain that there has been tremendous increase in fluke and flounder anglers since 1938 (Lobel 1939; Neville *et al.*, 1939; Westman, 1939).

The number of people per trip on the open boats and charter boat was highest during the summer (Table 4). Usually more fishermen wer carried per trip on the open boats. However, without exception, thi situation was reversed in May and September.

Usually more than a million and a half fluke alone were landed b the sport fisheries from June through September (Table 5). Nearly a great a number of winter flounder were caught in the spring and fall Together, these two species made up about 90 per cent of the yearly catc in Great South Bay (Table 5). In 1957 and again in 1960, when fluk were not landed in usual quantities, many winter flounder were caugh during the summer. The poorest catch per effort for fluke occurred i these years (see Table 9) and large numbers of anglers sought winte

TABLE 2. NUMBER OF ANGLERS IN THE GREAT SOUTH BAY AREA, BY MONTH FOR THE DIFFERENT FISHERIES, 1956–1960

Year	April	May	June	July	Aug.	Sept.	Oct.
Bank and pier							
1956	.....	.....	3,492	10,914	11,618	4,424	.....
1957	.....	.....	6,750	12,157	16,239	6,275	.....
1958	2,178	6,220	6,483	11,340	16,356	7,950	.....
1959	4,259	4,946	6,879	11,596	11,125	5,204	3,534
1960	7,086	5,886	7,410	11,112	11,740	5,046	3,461
Average	4,508	5,684	6,203	11,424	13,416	5,780	3,498
Rowboat							
1956	.....	.....	7,316	13,796	10,650	3,999	.....
1957	.....	.....	10,040	13,223	10,871	2,896	.....
1958	1,646	6,639	5,326	9,579	12,222	4,660	.....
1959	3,476	5,231	6,587	10,106	6,323	2,589	1,162
1960	3,164	4,337	7,485	9,418	6,491	2,732	1,045
Average	2,762	5,402	7,351	11,224	9,311	3,375	1,104
Open boat							
1956	.....	.....	19,331	22,932	9,649	6,149	.....
1957	.....	.....	11,803	13,814	6,588	2,961	.....
1958	8,646	8,516	12,026	16,199	18,889	5,666	.....
1959	7,658	17,781	18,674	26,152	19,177	7,655	3,125
1960	11,409	9,578	14,185	18,252	10,138	2,921	3,562
Average	9,238	11,958	15,204	19,470	12,888	5,070	3,344
Charter boat							
1956	.....	.....	7,163	19,908	13,039	7,434	.....
1957	.....	.....	18,046	15,248	11,380	5,768	.....
1958	5,778	12,593	11,920	9,568	7,857	3,476	.....
1959	6,037	10,065	8,131	8,371	8,848	4,345	2,300
1960	4,109	11,208	11,081	12,516	6,161	3,763	4,240
Average	5,308	11,289	11,268	13,122	9,457	4,957	3,270
Private boat							
1956	.....	.....	26,478	22,782	21,660	15,768	.....
1957	.....	.....	25,120	29,212	36,349	18,102	.....
1958	4,591	20,553	28,961	42,106	58,110	35,011	.....
1959	7,268	17,204	29,337	36,491	25,856	18,840	12,239
1960	8,059	18,382	27,917	33,153	28,282	16,487	18,679
Average	6,639	18,713	27,563	32,749	34,051	20,842	15,459

TABLE 2. (*continued*)

Year	April	May	June	July	Aug.	Sept.	Oct.
			Surf				
1956	.....	.....	210	366	727	1,210	.....
1957	.....	.....	576	575	1,257	1,250	.....
1958	462	942	438	712	879	721	.....
1959	487	544	378	799	666	1,109	667
1960	606	1,099	682	2,928	974	1,093	1,176
Average	518	862	457	1,076	901	1,077	922
			Total				
1956	.....	.....	63,990	90,698	67,343	38,984	.....
1957	.....	.....	72,335	84,229	82,684	37,252	.....
1958	23,301	55,463	65,154	89,504	114,313	57,484	.....
1959	29,185	55,771	69,986	93,515	71,995	39,742	23,027
1960	34,433	50,490	68,760	87,379	63,786	32,042	32,163
Average	28,973	53,908	68,045	89,065	80,024	41,101	27,595

TABLE 3. BOATS AVAILABLE TO THE PUBLIC IN THE GREAT SOUTH BAY AREA 1956–1960

Year	Open boats	Charter boats	Rowboats	
			Stations	Boats
1956	39	70	23	486
1957	36	69	24	492
1958	37	63	21	498
1959	36	66	20	447
1960	37*	56	19	444

* Includes seven boats available either as open boats or charter boats.

flounder well into summer (see Table 10). This relationship may be expected to recur during years of poor fluke fishing.

Of the other fishes, the most important was the bluefish. Snapper made up the bulk of the bank and pier fishermen's catch in August and September, while adult bluefish were important to the private boat and surf fishermen. Striped bass and kingfish (*Menticirrhus saxatilis*) were of great importance to the surf fishermen. Blackfish (*Tautoga onitis*) were

TABLE 4. AVERAGE NUMBER OF ANGLERS PER TRIP FOR OPEN BOATS AND CHARTER BOATS IN GREAT SOUTH BAY, BY MONTH, 1956–1960

Year	April	May	June	July	Aug.	Sept.	Oct.	Nov.
				Open boats				
1956..	....	....	20.5	20.9	19.1	14.5	14.0	....
1957..	....	....	17.9	18.2	17.6	15.4	....	....
1958..	10.6	7.6	11.0	15.7	17.0	13.9	13.7	12.5
1959..	11.5	16.4	17.4	18.4	18.3	14.0	11.6	12.0
1960..	14.2	14.4	21.9	21.3	17.9	10.9	12.2	15.2
				Charter boats				
1956..	....	....	16.3	18.1	18.3	15.5	....	....
1957..	....	....	17.8	19.4	17.9	16.5	....	....
1958..	10.2	10.6	13.9	15.3	16.2	15.4	11.0	13.5
1959..	13.6	17.4	17.9	17.7	18.5	16.0	11.2	8.0
1960..	12.8	16.0	15.0	14.6	11.1	12.9	11.1	11.0

important during spring and fall to the bank and pier, rowboat and private boat fishermen. The blowfish (*Sphaeroides maculatus*), although caught in good numbers, was generally considered a trash or nuisance fish by most anglers. Sea bass (*Centropristes striatus*) were caught in fair numbers through 1957, but after that they declined in importance within the bay and comprised only an extremely minor part of the catch. Common eels (*Anguilla rostrata*) and weakfish (*Cynoscion regalis*) comprised most of the catch of those fish listed in Table 5 as "others".

FLUKE AND WINTER FLOUNDER

The fluke is the species most sought by anglers during summer (Table 6). The open boat and charter boat fishermen were usually dependent entirely upon this fish during July, August, and often September (Tables 6 and 8). The only other fish normally sought by these anglers within the bay was the winter flounder (see Table 12). The rowboat fishermen were only slightly less dependent upon fluke during the summer than the open boat and charter boat fishermen. Fluke comprised an important part of the catch of the bank and pier fishermen only from May through July, despite the fact that a large percentage of these anglers sought them well into September. Since 1957 private boat fishermen have become less dependent upon fluke than other boat fishermen. Nevertheless, this fishery was still heavily dependent upon fluke and had more fluke anglers and landed more fluke than any of the other fisheries (Table 7). The surf fishery was the only sport fishery not dependent upon the fluke.

Table 5. Composition of Catch in the Great South Bay Area, 1956–1960

Species	June to September					April to October		
	1956	1957	1958	1959	1960	1958 ‡	1959	1960
Fluke								
Number	1,783,929	790,798	1,508,330	1,538,552	919,018	1,512,312	1,642,917	986,378
Per cent	90.9	54.6	66.4	87.1	65.3	48.3	50.9	31.9
Flounder								
Number	121,063	474,434	304,859	82,577	328,836	1,101,662	1,384,616	1,861,509
Per cent	6.2	32.8	13.4	4.7	23.4	35.2	42.9	60.2
Snapper*								
Number	43,304	50,567	324,801	92,420	53,559	324,801	93,088	53,957
Per cent	2.2	3.5	14.3	5.2	3.8	10.4	2.9	1.7
Bluefish								
Number	10,490†	27,675	604	41,450	47,872	604	42,770	49,084
Per cent	0.5	1.9	tr.	2.3	3.4	tr.	1.3	1.6
Striped bass								
Number	388	366	346	521	9,913	346	885	28,261
Per cent	tr.	tr.	tr.	tr.	0.7	tr.	tr.	0.9
Kingfish								
Number	291	2,622	1,951	3,816	2,871	2,261	6,650	4,094
Per cent	tr.	0.2	0.1	0.2	0.2	0.1	0.2	0.1
Blackfish								
Number	182	72,800	66,017	4,889	22,719	91,279	30,139	49,110
Per cent	tr.	5.0	2.9	0.3	1.6	2.9	0.9	1.6

TABLE 5. (*continued*)

Species	June to September					April to October		
	1956	1957	1958	1959	1960	1958	1959	1960
Blowfish								
Number	1,063	497	21,058	2,067	19,797	49,876	27,300	58,185
Per cent	0.1	tr.	0.9	0.1	1.4	1.6	0.8	1.9
Sea bass								
Number	1,190	10,642	298	0	985	298	12	1,019
Per cent	0.1	0.7	tr.	0.0	0.1	tr.	tr.	tr.
Others§								
Number	0	16,945	43,698	380	1,208	47,209	465	3,846
Per cent	0.0	1.2	1.9	tr.	0.1	1.5	tr.	0.1
Total	1,961,900	1,447,346	2,271,962	1,766,672	1,406,778	3,130,648	3,228,842	3,095,443

* Immature bluefish.
§ Includes weakfish, eel, mackerel, pilot fish, porgy, sea robin, ling, and dogfish.
† Excluding September catch from private boats.
‡ Covers only April to September.

TABLE 6. PERCENTAGE OF ANGLERS IN GREAT SOUTH BAY WHO SOUGHT FLUKE, BY MONTH FOR THE DIFFERENT FISHERIES, 1956–1960

Year	May	June	July	Aug.	Sept.	Oct.
Bank and pier						
1956	....	90.4	95.3	75.7	26.3	4.8
1957	....	90.8	70.8	41.6	27.9	7.6
1958	16.0	80.0	82.4	34.3	47.0	7.5
1959	8.8	67.1	79.9	60.5	47.7	9.7
1960	12.7	69.7	83.6	39.2	29.2	4.1
Rowboat						
1956	....	100.0	100.0	99.5	98.5	24.1
1957	....	90.5	94.7	93.4	82.4	6.3
1958	17.3	66.5	88.0	93.3	83.9	28.3
1959	24.6	94.8	98.6	93.2	91.9	23.3
1960	34.7	95.7	97.3	96.9	88.2	25.3
Open boat						
1956	....	100.0	100.0	100.0	89.9	0.0
1957	....	96.5	90.7	88.3	98.3	....
1958	0.0	56.3	100.0	100.0	100.0	24.4
1959	25.7	98.8	100.0	100.0	71.2	16.2
1960	30.1	99.4	97.5	100.0	88.2	4.6
Charter boat						
1956	....	100.0	100.0	100.0	100.0	....
1957	....	85.2	100.0	100.0	100.0	....
1958	0.0	70.4	100.0	100.0	100.0	....
1959	17.0	100.0	100.0	100.0	100.0	17.7
1960	43.7	98.0	89.3	62.8	68.4	56.9
Private boat						
1956	....	100.0	100.0	100.0	....	....
1957	....	77.6	71.2	69.9	52.3	....
1958	2.7	88.7	100.0	100.0	72.0	10.4
1959	28.6	95.8	82.0	86.0	62.7	32.5
1960	34.9	94.3	94.6	71.0	34.1	7.4
Total*						
1956	....	99.3	99.1	94.5	....	....
1957	....	85.1	82.9	72.0	59.9	....
1958	14.4	76.1	95.6	88.9	73.0	....
1959	23.5	93.6	89.5	87.3	66.6	23.9
1960	32.6	92.5	90.2	70.5	45.7	13.6

* Exclusive of surf anglers.

TABLE 7. MONTHLY AND ANNUAL CATCH OF FLUKE IN THE GREAT SOUTH BAY AREA, 1956–1960

Year	Fishery						Total	
	Bank and pier	Surf	Row-boat	Open boat	Charter boat	Private boat	Number	Per cent*
May								
1958	303	§	3,217	0	0	462	3,982	0.3
1959	935	0	8,081	40,646	14,689	31,730	96,081	5.9
1960	464	15	2,999	11,099	19,139	18,850	52,566	5.3
Average	.....	...	.....	.....	.....	.....	50,876	3.7
June								
1956	4,072	§	65,848	216,505	78,075	238,302	602,802	33.8
1957	2,097	§	77,231	82,008	135,300	101,364	398,000	50.3
1958	3,131	§	20,189	62,293	53,709	179,816	319,138	21.1
1959	4,269	0	44,973	184,215	73,502	301,466	608,425	37.0
1960	2,868	14	42,443	97,869	69,713	209,904	422,811	42.9
Average	.....	...	.....	.....	.....	.....	470,235	34.4
July								
1956	9,024	§	129,679	236,200	169,215	214,151	758,269	42.6
1957	1,780	§	37,566	66,404	54,893	87,356	247,999	31.4
1958	4,696	§	41,351	97,194	51,667	231,583	426,491	28.2
1959	4,591	3	54,983	186,988	61,984	245,518	554,067	33.7
1960	4,971	83	39,566	95,476	59,152	152,792	352,040	35.7
Average	.....	...	.....	.....	.....	.....	467,773	34.1
August								
1956	7,407	§	42,598	76,226	65,195	86,640	278,066	15.6
1957	716	§	15,231	28,503	35,278	37,949	117,677	14.9
1958	2,244	§	61,576	111,445	46,356	331,227	552,848	36.5
1959	2,459	18	26,016	123,216	54,311	73,795	279,815	17.0
1960	1,450	7	18,469	36,699	18,909	23,868	99,402	10.1
Average	.....	...	.....	.....	.....	.....	265,562	19.4
September								
1956	2,254	§	6,798	64,562	42,372	28,806	144,792	8.0
1957	388	§	2,147	4,367	9,806	10,414	27,122	3.4
1958	1,499	§	23,069	34,563	14,599	136,123	209,853	13.9
1959	527	32	5,318	26,236	20,050	44,082	96,245	5.9
1960	452	0	6,952	9,653	8,077	19,631	44,765	4.5
Average	.....	...	.....	.....	.....	.....	104,555	7.6

Table 7. (*continued*)

Year	Fishery						Total	
	Bank and pier	Surf	Row-boat	Open boat	Charter boat	Private boat	Number	Per cent*
				October				
1959....	36	10	174	593	705	6,766	8,284	0.5
1960....	28	0	489	330	11,715	2,232	14,794	1.5
Average.	.....	...	.....	.....	.....	.....	11,359	0.8
				Total				
1956....	22,757	§	244,923	593,493	354,857	567,899	1,783,929	100.0
1957....	4,981	§	132,175	181,282	235,277	237,083	790,798	100.0
1958....	11,873	§	149,402	305,495	166,331	879,211	1,512,312	100.0
1959....	12,817	63	139,545	561,894	225,241	703,357	1,642,917	100.0
1960....	10,233	119	110,918	251,126	186,705	427,277	986,378	100.0
Average.	.....	...	.....	.....	.....	.....	1,343,267	.....

* Monthly values for each year based on sum of catches for that year; values for "average" based on sum of average catches for all months (i.e., 1,370,360).
§ Included with bank and pier fishery.

In every year of this study except 1958, about three-fourths of the fluke catch was taken in June and July, after which a sharp drop occurred (Table 7). This appeared to be the normal form of the fluke season. Data for catch per effort in general paralleled this peak and decline (Table 9). In 1958, the catch reached a peak in August and catch per effort did not show a sharp decline after July. Neville *et al.* (1939) found that in 1938 the fluke season followed a pattern similar to that of 1958. However, since 1938 there has been a tremendous increase in fishing for fluke in Great South Bay, and the private boat fishery was not sampled in 1938. The increase in fishing since 1938 may be a factor in the changed form of the fluke season.

It is interesting to compare the fluke catch per effort for the large, guided boats of the open boat and charter boat fisheries with that for the small, unguided boats of the rowboat and private boat fisheries (Table 9). The consistently greater effectiveness of the larger craft in catching fluke is shown; much of this is due to the individual boat captain's knowledge of the fish and the waters where they are normally found.

The catch per effort of the bank and pier fishermen was quite poor (Table 9). It can be seen that, although a high percentage of the anglers in this fishery sought fluke, their low catch per effort accounted for its

TABLE 8. PERCENTAGE OF FLUKE IN CATCH IN GREAT SOUTH BAY, BY MONTH FOR THE DIFFERENT FISHERIES, 1956–1960

Year	May	June	July	Aug.	Sept.	Oct.
Bank and pier						
1956	....	52.8	91.7	14.6	2.7	1.5
1957	....	38.5	9.2	1.4	0.9	0.1
1958	3.7	40.7	25.5	1.5	2.4	0.5
1959	3.0	23.3	40.4	5.3	2.2	0.3
1960	1.8	40.4	36.7	4.2	2.3	0.4
Rowboat						
1956	....	89.6	99.9	94.6	85.1	3.5
1957	....	78.0	89.5	81.8	31.5	0.3
1958	1.2	44.8	76.1	84.7	76.4	13.5
1959	10.0	79.8	98.9	82.5	52.7	2.6
1960	4.1	60.5	76.1	82.5	53.2	6.5
Open boat						
1956	....	84.1	100.0	99.8	88.8	0.0
1957	....	46.3	83.8	66.4	82.4	7.5
1958	0.0	42.4	100.0	100.0	100.0	....
1959	15.0	97.8	100.0	99.8	54.5	1.8
1960	5.6	77.4	78.1	100.0	67.7	0.7
Charter boat						
1956	....	70.1	100.0	100.0	100.0	....
1957	....	51.9	99.4	98.4	100.0	....
1958	0.2	63.1	100.0	99.5	....	....
1959	8.5	100.0	99.9	99.8	98.0	3.3
1960	8.3	63.9	78.1	66.6	57.2	24.9
Private boat						
1956	....	100.0	100.0	96.2	....	....
1957	....	52.8	67.8	50.0	19.9	....
1958	1.7	55.2	85.9	81.2	68.4	5.8
1959	11.5	92.9	92.9	79.5	59.7	8.4
1960	5.8	65.6	75.1	55.1	31.5	1.6

small contribution to the over-all fluke catch for Great South Bay. Only during May and June of good fluke years were bank and pier anglers able to take one fish per angler per trip.

During May and October, in all the fisheries, the lowest numbers of fluke were taken and the fewest anglers sought fluke. Recently there appears to have been a tendency to start fishing for fluke earlier in May

Table 9. Comparison of Fluke Catch per Effort in Great South Bay for Large Boats with Guides, Small Boats without Guides and Bank and Pier Fishing, by Month, 1956–1960

Type of fishing	1956	1957	1958	1959	1960
May					
Boats with guides					
Open boats	....	....	....	9.0	3.9
Charter boats	....	....	....	8.3	3.9
Boats without guides					
Rowboats	....	....	....	6.1	2.0
Private boats	....	....	....	6.2	2.9
Bank and pier	....	....	0.3	1.0	0.6
June					
Boats with guides					
Open boats	11.2	9.6	9.2	10.0	6.9
Charter boats	10.9	6.9	6.4	9.0	6.4
Boats without guides					
Rowboats	9.0	8.5	5.7	7.2	5.9
Private boats	....	5.2	7.0	10.7	8.0
Bank and pier	1.3	0.3	0.6	0.9	0.6
July					
Boats with guides					
Open boats	10.3	5.3	6.0	7.2	5.4
Charter boats	8.5	3.6	5.4	7.4	5.3
Boats without guides					
Rowboats	9.0	8.5	5.7	5.5	4.3
Private boats	....	4.2	5.5	8.8	4.9
Bank and pier	0.8	0.2	0.5	0.5	0.6
August					
Boats with guides					
Open boats	7.9	4.9	5.9	6.4	3.6
Charter boats	5.0	3.1	5.9	6.1	4.9
Boats without guides					
Rowboats	4.0	1.5	5.4	4.3	2.9
Private boats	....	1.5	5.7	3.3	1.2
Bank and pier	0.6	0.1	0.4	0.4	0.3

TABLE 9. (*continued*)

Type of fishing	1956	1957	1958	1959	1960
September					
Boats with guides					
Open boats	10.5	1.5	6.1	4.3	3.7
Charter boats	5.7	1.7	4.2	4.6	3.1
Boats without guides					
Rowboats	1.7	0.9	5.9	2.2	2.9
Private boats	....	1.1	5.4	3.7	3.5
Bank and pier	0.4	0.2	0.4	0.2	0.3
October					
Boats with guides					
Open boats				1.2	2.0
Charter boats				1.7	3.3
Boats without guides					
Rowboats	....	....	....	0.6	1.9
Private boats	....	....	....	1.7	1.6
Bank and pier	....	0.1	0.2	0.1	0.2

(Table 7). The findings of Poole (1961) indicate that the majority of fluke caught are 1- and 2-year-old fish, that the fluke is heavily exploited, and that two consecutive poor spawning seasons might be disastrous to fluke fishing. In view of this and the low proportion of anglers seeking fluke in May and October, as well as the comparatively small percentage of the over-all fluke catch that is taken in May (usually about 5 per cent) and October (an average of less than 1 per cent), the small contribution of the fluke to the total catch of the fisheries at this time (Tables 7 and 8), and the availability of winter flounder and blackfish (Tables 11 and 19), it may be desirable to restrict fluke fishing during these months.

The winter flounder is equally as important as the fluke to the sport fishermen of Great South Bay. In April, November and December, this was the only fish normally sought by all anglers other than surf anglers (Table 10). Surf fishermen seldom take it.

In many instances, the combined percentages of the anglers seeking fluke and of those seeking winter flounder exceed 100 per cent. This is an indication, particularly noticeable for June, that anglers will often seek more than one species, changing their terminal tackle to catch whichever of the two flatfish is biting better at a particular time.

More winter flounder were caught in May than in any other month (Table 11). In 1957 and in 1960, great numbers were caught in July.

Table 10. Percentage of Anglers in Great South Bay Who Sought Flounder, by Month for the Different Fisheries, 1956-1960

Year	April	May	June	July	August	September	October	November	December
Bank and pier									
1956	....	....	29.2	0.0	3.7	41.2	96.1	....	....
1957	....	....	4.7	16.2	14.0	19.4	62.3	99.2	....
1958	100.0	84.5	27.4	13.1	4.6	10.7	80.1	95.4	....
1959	100.0	87.0	32.4	13.8	3.0	13.1	69.7	100.0	100.0
1960	100.0	95.3	38.5	18.4	0.6	5.7	76.0	100.0	100.0
Rowboat									
1956	....	....	8.1	0.0	0.0	5.5	86.7	....	....
1957	....	....	16.5	3.9	2.4	2.4	63.9	98.5	....
1958	100.0	97.8	46.6	16.1	3.5	12.7	81.9	100.0	....
1959	100.0	85.6	5.5	0.0	0.0	10.7	66.3	100.0	....
1960	100.0	98.6	35.7	15.0	0.0	3.3	77.9	100.0	100.0
Open boat									
1956	....	....	13.0	0.0	0.0	7.6	100.0	....	....
1957	....	....	53.5	9.3	11.7	1.7	....	....	....
1958	100.0	100.0	43.8	0.0	0.0	0.0	80.5	100.0	....
1959	100.0	83.4	1.2	0.0	0.0	28.8	99.3	100.0	....
1960	100.0	98.6	16.1	14.0	0.0	13.2	99.7	100.0	100.0
Charter boat									
1956	....	....	32.4	0.0	0.0	0.0	....	....	....
1957	....	....	37.0	0.0	0.0	0.0	....	....	....
1958	100.0	100.0	29.3	0.0	0.0	0.0	....	100.0	....
1959	100.0	92.5	0.0	0.0	0.0	0.0	96.8	100.0	....
1960	100.0	95.4	29.0	11.7	0.0	10.5	60.8	100.0	....
Private boat									
1956	....	....	....	0.0	0.0	0.0	....	....	....
1957	....	....	58.6	6.8	2.9	0.0	....	....	....
1958	100.0	96.3	43.3	10.5	0.0	0.0	83.0	100.0	....
1959	100.0	79.2	4.3	0.0	0.0	4.3	57.3	100.0	100.0
1960	100.0	92.4	30.6	17.7	0.0	8.6	50.7	100.0	100.0

TABLE 11. MONTHLY AND ANNUAL CATCH OF WINTER FLOUNDER IN THE GREAT SOUTH BAY AREA, 1956–1960

Year	Fishery					Total	
	Bank and pier*	Row-boat	Open boat	Charter boat	Private boat	Number	Per cent§
April							
1958	871	8,888	82,137	19,645	39,942	151,483	13.7
1959	5,537	59,814	156,756	102,458	148,413	472,978	34.2
1960	14,465	66,916	270,736	100,753	135,478	588,348	31.6
Average	.....	.....	.....	.....	.....	404,270	26.5
May							
1958	3,679	83,760	141,366	188,895	227,620	645,320	58.6
1959	23,869	66,996	228,874	155,703	229,274	704,716	50.9
1960	17,342	63,953	186,780	206,144	273,942	748,161	40.2
Average	.....	.....	.....	.....	.....	699,399	45.8
June							
1956	5,610	5,811	58,050	39,675	0	109,146	90.2
1957	1,046	11,930	95,357	129,534	153,088	390,955	82.4
1958	2,309	24,820	85,852	46,806	117,876	277,663	25.2
1959	11,331	9,794	4,277	0	22,096	47,498	3.4
1960	7,088	23,388	27,912	39,436	102,025	199,849	10.7
Average	.....	.....	.....	.....	.....	205,022	13.4
July							
1956	0	0	0	0	0	0	0.0
1957	3,150	2,786	16,834	0	25,421	48,191	10.2
1958	2,378	10,486	0	0	7,047	19,911	1.8
1959	3,083	11	0	0	0	3,094	0.2
1960	5,694	11,435	28,408	16,334	47,470	109,341	5.9
Average	.....	.....	.....	.....	.....	36,107	2.4
August							
1956	1,849	0	0	0	0	1,849	1.5
1957	14,775	1,592	11,102	0	2,180	29,649	6.2
1958	779	1,198	0	0	0	1,977	0.2
1959	714	0	0	0	0	714	0.1
1960	69	0	0	0	0	69	tr.
Average	.....	.....	.....	.....	.....	6,852	0.5

Table 11. (*continued*)

Year	Fishery					Total	
	Bank and pier*	Row-boat	Open boat	Charter boat	Private boat	Number	Per cent§
				September			
1956.....	4,193	1,298	4,577	0	0	10,068	8.3
1957.....	3,894	595	1,150	0	0	5,639	1.2
1958.....	1,874	3,434	0	0	0	5,308	0.5
1959.....	3,316	1,519	21,037	0	5,399	31,271	2.2
1960.....	590	222	3,591	4,648	10,526	19,577	1.1
Average.....	.....	.....	.....	.....	.....	14,373	0.9
				October			
1959.....	8,338	4,848	30,686	20,149	60,324	124,345	9.0
1960.....	4,214	5,056	45,542	34,901	106,451	196,164	10.5
Average.....	.....	.....	.....	.....	.....	160,255	10.5
				Total			
1956.....	11,652	7,109	62,627	39,675	0	121,063	100.0
1957.....	22,865	16,903	124,443	129,534	180,689	474,434	100.0
1958.....	11,890	132,586	309,355	255,346	392,485	1,101,662	100.0
1959.....	56,188	142,982	441,630	278,310	465,506	1,384,616	100.0
1960.....	49,462	170,970	562,969	402,216	675,892	1,861,509	100.0
Average.....	.....	.....	.....	.....	.....	988,677	.....

* Includes surf fishery for 1956 and 1957, the only years a catch of winter flounder was recorded for these fishermen.

§ Monthly values for each year based on sum of catches for that year; values for "average" based on sum of average catches for all months (i.e., 1,526,278).

July and August of 1957 and July of 1960 were the only midsummer months in which winter flounder comprised more than 5 per cent of the catch of all species in Great South Bay. It has already been noted that these were years of poor fluke fishing, and that this compensatory relationship may be expected when such conditions recur. The majority of a year's flounder catch had been landed by the end of May. Normally, only bank and pier anglers sought flounder through July and August.

The private boat fishery led the other fisheries in numbers of winter flounder caught in all months except April. The catch for this fishery was comparatively low in April because many of the private boats were undergoing seasonal repairs.

In April, common eels were the only fish other than winter flounder

TABLE 12. PERCENTAGE OF FLOUNDER IN CATCH IN GREAT SOUTH BAY, BY MONTH FOR THE DIFFERENT FISHERIES, 1956–1960

Year	April	May	June	July	August	September	October	November	December
Bank and pier									
1956	....	....	42.5	0.0	4.0	22.1	68.4	....	....
1957	....	....	40.1	77.8	24.2	15.3	24.6	92.6	....
1958	100.0	39.8	27.7	15.5	0.7	2.8	56.5	76.4	....
1959	100.0	77.1	61.9	27.1	1.5	14.1	66.9	100.0	100.0
1960	98.1	68.4	40.4	42.0	0.2	3.0	51.8	100.0	100.0
Rowboat									
1956	....	....	10.4	0.0	0.0	5.4	87.5	....	....
1957	....	....	16.1	5.4	6.5	7.3	43.1	97.6	....
1958	100.0	88.8	43.8	19.1	1.6	11.3	76.6	94.2	....
1959	100.0	82.7	17.4	0.0	0.0	15.1	73.5	100.0	....
1960	99.7	86.6	33.3	22.0	0.0	1.7	67.3	100.0	100.0
Open boat									
1956	....	....	15.9	0.0	0.0	9.6	100.0	....	....
1957	....	....	53.7	17.5	32.9	10.0	....	....	....
1958	100.0	99.1	56.6	0.0	0.0	0.0	92.4	100.0	....
1959	100.0	84.2	2.3	0.0	0.0	43.7	92.6	100.0	....
1960	100.0	94.1	22.1	21.7	0.0	25.2	99.3	100.0	100.0
Charter boat									
1956	....	....	29.9	0.0	0.0	0.0	....	....	....
1957	....	....	48.1	0.0	0.0	0.0	....	....	....
1958	100.0	97.8	35.3	0.0	0.0	0.0	....	100.0	....
1959	100.0	90.1	0.0	0.0	0.0	0.0	93.8	100.0	....
1960	100.0	89.7	36.1	21.5	0.0	32.9	74.1	100.0	....
Private boat									
1956	....	....	0.0	0.0	0.0	0.0	....	....	....
1957	....	....	52.7	16.2	2.7	....	....	....	....
1958	99.8	91.1	55.2	9.9	0.0	0.0	75.7	96.6	....
1959	100.0	82.9	6.8	0.0	0.0	7.3	75.6	100.0	100.0
1960	99.7	84.6	31.9	23.3	0.0	16.9	77.6	100.0	100.0

Table 13. Comparison of Flounder Catch per Effort in Great South Bay, by Month for the Different Fisheries, 1956–1960

Year	April	May	June	July	August	September	October	November	December
Bank and pier									
1956	....	....	5.5	*	4.3	2.3	1.8	....	....
1957	....	....	3.3	6.1	6.5	3.2	1.8	1.1	....
1958	0.4	0.7	1.3	1.6	1.6	1.8	1.9	0.9	....
1959	1.3	5.5	5.0	1.9	2.1	4.1	3.1	1.7	0.9
1960	2.1	3.1	2.5	2.8	1.0	2.1	1.6	1.9	0.9
Rowboat									
1956	....	....	9.8	*	*	5.9	7.9	....	....
1957	....	....	7.2	5.4	6.1	8.5	5.9	9.7	....
1958	5.4	12.9	10.0	6.8	2.8	5.8	7.0	10.4	....
1959	17.2	15.0	27.1	*	*	5.5	6.0	12.3	....
1960	21.2	15.0	8.8	8.1	*	2.4	6.2	12.0	10.1
Open boat									
1956	....	....	23.1	*	*	9.8	11.5	....	....
1957	....	....	15.1	13.1	14.4	23.0	....	15.5	....
1958	9.5	16.6	16.3	*	*	*	14.8	15.0	....
1959	20.5	15.4	19.0	*	*	9.5	9.9	24.4	....
1960	23.7	19.8	12.2	10.3	*	9.3	12.4	20.6	10.6
Charter boat									
1956	....	....	17.1	*	*	*	....	....	....
1957	....	....	19.4	*	*	*	....	....	....
1958	3.4	15.0	13.4	*	*	*	....	14.9	....
1959	17.0	16.7	0.0	*	*	*	9.1	24.4	....
1960	24.5	19.3	12.3	11.1	*	11.8	9.2	17.9	....
Private boat									
1956	....	....	*	*	*	....	....	....	....
1957	....	....	10.4	12.8	2.0	*	....	....	....
1958	8.7	11.5	9.4	1.6	*	*	7.9	9.4	....
1959	20.4	16.8	17.7	*	*	6.6	8.5	13.0	18.4
1960	22.1	16.1	12.0	8.1	*	7.4	11.3	16.3	8.1

* No effort expended by fishermen checked.

that were recorded taken in the bay. They were caught incidentally to the prime objectives of the bay anglers (Tables 10 and 12). The common eel is not sought by anglers and never constituted an appreciable part of the catch of any fishery. The late fall and winter catch for all the bay fisheries was similarly dominated by the winter flounder.

Catch per effort was higher for winter flounder than for any other fish taken by the rowboat, open boat, charter boat, and private boat fisheries (Table 13). In the bank and pier fishery, only that for snapper bluefish exceeded it. As in the case of the fluke, fishermen using the larger, guided craft (open and charter boats) caught winter flounder at a greater rate than those in the other fisheries. Catch per effort was generally at its highest in April and declined as summer approached. In the fall and early winter it usually reached a peak in November. However, less fishing for this species was done in fall than in the spring (Table 11).

BLUEFISH

The bluefish ranks next in importance to the two flatfish. Snappers formed the bulk of the catch by bank and pier fishermen in August and September (Table 14). Except during 1958, nearly all the snappers landed were taken by this fishery. These small fish usually appeared first in the catch in July and remained until October. The greatest catches were made in 1958; after that there was a decline both in number caught and in catch per effort. In 1960, snappers were not taken in July, a month in which they are usually caught, and the catch per effort in August was the lowest since 1956. Despite this decline, snappers comprised more than 90 per cent of the total catch by bank and pier anglers in August after 1958. The decreased catch per effort during 1960 may have been due to two factors: competition for the anglers' bait by a tremendous number of young-of-the-year blowfish; and a bloom of algae (*Cladophora*) in August and early September which made angling difficult by fouling hooks.

Despite the high percentage of snappers in the catch of bank and pier anglers during August and September, only in 1958 and 1960 did more than 40 per cent of these anglers seek this fish. Catch per effort was greater for snappers than for any other fish caught by bank and pier anglers.

The snapper appeared to be underutilized by both the rowboat and private boat fisheries. Perhaps the decline in anglers during late summer and early fall in these fisheries could be eased if advantage were taken of the schools of snappers near the bay shores. Future development of snapper fishing would also help to lessen the pressure on the heavily exploited fluke.

Adult bluefish were taken by all the fisheries, although normally

Table 14. Monthly Catch of "Snapper" Bluefish by Bank and Pier Anglers in Great South Bay and Comparison of Total Catch by this Fishery with That of Other Fisheries, 1956–1960

Item	1956	1957	1958	1959	1960
July					
Catch					
Number	258	873	8,616	3,375	0
Per cent of total*	4.9	5.7	49.1	29.7	0.0
Catch per effort	1.3	4.5	8.0	7.1	.....
Anglers seeking bluefish					
Number	200	194	1,077	474	0
Per cent§	1.8	1.6	9.5	4.1	0.0
August					
Catch					
Number	27,413	39,648	160,791	43,180	31,194
Per cent of total*	75.7	69.8	97.2	93.1	91.0
Catch per effort	8.4	5.6	14.5	9.7	4.3
Anglers seeking bluefish					
Number	3,248	7,080	11,089	4,454	7,182
Per cent§	28.0	43.6	67.8	40.0	61.2
September					
Catch					
Number	13,052	7,925	48,691	16,116	15,559
Per cent of total*	70.4	27.8	91.5	68.5	78.1
Catch per effort	8.5	4.1	10.2	8.2	5.0
Anglers seeking bluefish					
Number	1,541	1,933	4,778	1,966	3,088
Per cent§	34.8	30.8	60.1	37.8	61.2
October					
Catch					
Number	.....	.....	.....	620	415
Per cent of total*	24.6†	5.3†	2.7†	5.0	5.1
Catch per effort	4.0†	2.6†	3.7†	3.8	2.2
Anglers seeking bluefish					
Number	.....	.....	.....	162	190
Per cent§	15.7†	9.2†	1.9†	4.6	4.5
Total snapper catch					
Bank and pier	40,723	48,446	218,098	63,291	47,168
Other fisheries	2,581	2,121	106,703	29,797	6,789
Total	43,304	50,567	324,801	93,088	53,957

* Based on catch of all species by bank and pier anglers during month.
§ Based on total bank and pier anglers.
† In the absence of aerial counts of anglers as a basis for calculating both total anglers and total catch, values derived from data obtained during interviews were used.

TABLE 15. COMPARISON OF BLUEFISH CATCH AND ANGLERS WHO SOUGHT BLUEFISH IN GREAT SOUTH BAY FOR CHARTER BOATS AND PRIVATE BOATS, BY MONTH, 1956–1960

Item	1956	1957	1958	1959	1960
July					
Catch *					
Number					
Charter boat	0	303	0	43	486
Private boat	0	280	0	18,679	2,117
Per cent of total §					
Charter boat	0.0	0.6	0.0	0.1	0.6
Private boat	0.0	0.3	0.0	7.1	1.0
Catch per effort					
Charter boat	†	†	†	†	2.2
Private boat	†	†	†	2.8	1.6
Anglers seeking bluefish					
Number					
Charter boat	0	0	0	0	225
Private boat	0	0	0	6,568	1,359
Per cent §§					
Charter boat	0.0	0.0	0.0	0.0	1.8
Private boat	0.0	0.0	0.0	18.0	4.1
August					
Catch *					
Number					
Charter boat	0	574	0	103	9,491
Private boat	3,432	6,252	0	5,477	17,343
Per cent of total §					
Charter boat	0.0	1.6	0.0	0.2	33.4
Private boat	3.8	12.2	0.0	5.9	40.6
Catch per effort					
Charter boat	†	†	†	†	2.4
Private boat	0.4	4.0	†	1.3	1.7
Anglers seeking bluefish					
Number					
Charter boat	0	0	0	0	4,004
Private boat	7,646	1,563	0	4,370	10,097
Per cent §§					
Charter boat	0.0	0.0	0.0	0.0	65.1
Private boat	35.3	4.3	0.0	16.9	35.7
September					
Catch *					
Number					
Charter boat	0	0	0	413	1,384
Private boat	‡	16,019	511	15,826	13,960
Per cent of total §					
Charter boat	0.0	0.0	0.0	2.0	9.8
Private boat	‡	28.4	0.2	21.4	22.4
Catch per effort					
Charter boat	†	†	†	†	1.6
Private boat	4.0	3.5	0.2	2.0	1.4
Anglers seeking bluefish					
Number					
Charter boat	0	0	0	0	858
Private boat	‡	4,526	0	7,103	10,041
Per cent §§					
Charter boat	0.0	0.0	0.0	0.0	22.8
Private boat	‡	25.0	0.0	37.7	60.9

Table 15. (*continued*)

Item	1956	1957	1958	1959	1960
October					
Catch *					
Number					
Charter boat	.....	.....	.....	0	490
Private boat	.....	.....	.....	1,210	685
Per cent of total§					
Charter boat	.....	.....	.....	0.0	7.8
Private boat	.....	.....	.....	1.5	0.5
Catch per effort					
Charter boat	.....	.....	.....	†	1.0
Private boat	.....	.....	.....	0.7	0.7
Anglers seeking bluefish					
Number					
Charter boat	.....	.....	.....	0	331
Private boat	.....	.....	.....	1,691	2,148
Per cent§§					
Charter boat	.....	.....	.....	0.0	7.8
Private boat	.....	.....	.....	13.8	11.5
Total catch (July-September)					
Charter boat	0	877	0	559	11,361
Private boat	‡	22,551	511	39,982	33,420

* In some instances a catch is given without a corresponding figure for anglers such fish were taken incidentally by anglers seeking other species.
§ Based on catch of all species for each fishery, respectively, during month.
§§ Based on total anglers in each fishery, respectively.
† No effort expended by fishermen checked.
‡ Sample data inadequate.

they are actively sought for only by anglers in the private boat and sur fisheries. During the late summer and early fall of 1960, charter boa anglers actively fished for bluefish within the bay. This was the only time during the course of this study that these fishermen sought othe than fluke or winter flounder within the bay. The bluefish taken prio to 1960 within the bay by this fishery were caught incidentally by angler fishing for fluke. Although the bluefish catch fluctuated greatly fron year to year and the catch per effort was relatively low, bluefish were usually important to the private boat fishery (Table 15). Their grea importance to the surf fishery will be discussed later. The private boa fishery landed the greatest number of bluefish and had the greatest num ber of anglers seeking them. The larger, guided craft (in this case only charter boats), when they sought bluefish, had the highest catch pe effort. Fluctuations in the number of bluefish were noticeable in th decline of the catch per effort and in the poor total catch during 1958 fo

the private boat fishery as compared with those during other years of the study. Interestingly, although poor catches of bluefish also occurred in the surf fishery in 1958, the catch per effort did not decline greatly (see Table 25).

When bluefish were apparently available in numbers, more than a quarter of the private boat anglers generally sought them. In September 1960, the proportion exceeded 60 per cent (Table 15). For the charter boat fishery in 1960, nearly two-thirds of the anglers in August, and nearly a quarter of those in September, sought bluefish.

In September, bluefish usually comprised about 20 per cent of the private boat catch (Table 15). In August 1960, the proportion was more than 40 per cent, and, in this same month, they constituted more than a third of the charter boat catch.

BLACKFISH

The blackfish is normally an important part of the catch of rowboat, private boat, and bank and pier fishermen. In addition to being sought by these anglers, many blackfish were taken incidentally by those who were seeking winter flounder. Catch per effort (Table 16) is based on

TABLE 16. MONTHLY CATCH OF BLACKFISH IN GREAT SOUTH BAY, BY MONTH FOR DIFFERENT FISHERIES, 1956–1960

Year	May	June	July	Aug.	Sept.	Oct.
Bank and pier						
1956	.....	97	0	0	85	.....
1957	.....	522	1,116	1,262	10,153	.....
1958	6,326	864	1,007	1,824	1,377	.....
1959	2,715	915	315	0	1,388	2,229
1960	2,339	2,186	1,433	528	2,049	1,196
Rowboat						
1956	.....	0	0	0	0	.....
1957	.....	5,508	1,106	750	3,094	.....
1958	7,160	1,474	1,181	245	1,043	.....
1959	1,684	541	0	0	391	1,287
1960	1,514	1,327	738	54	2,829	1,025
Private boat						
1956	.....	0	0	0	.....	.....
1957	.....	0	14,899	16,150	18,070	.....
1958	11,432	21,569	11,495	0	23,938	.....
1959	4,094	0	0	0	569	11,007
1960	8,907	896	448	0	10,196	11,364

Table 17. Percentage of Blackfish in Catch in Great South Bay, by Month for Different Fisheries, 1956–1960

Year	May	June	July	Aug.	Sept.	Oct.
Bank and pier						
1956.....	....	8.3	0.0	0.0	5.3	1.5
1957.....	....	12.6	7.2	2.5	36.4	45.4
1958.....	24.8	10.7	6.4	0.5	2.6	39.4
1959.....	8.9	5.0	2.8	0.0	5.9	17.9
1960.....	9.2	12.5	10.6	1.5	10.3	14.7
Rowboat						
1956.....	....	0.0	0.0	0.0	0.0	1.5
1957.....	....	5.3	1.7	2.3	37.2	31.2
1958.....	2.8	2.6	2.2	0.3	3.5	9.9
1959.....	2.1	1.0	0.0	0.0	3.9	19.5
1960.....	2.1	1.9	1.4	0.2	21.6	13.6
Private boat						
1956.....	....	0.0	0.0	0.0	....	....
1957.....	....	10.4	11.9	23.6	33.3	....
1958.....	4.6	6.4	4.2	0.0	11.1	18.5
1959.....	1.5	0.0	0.0	0.0	0.8	13.7
1960.....	2.8	0.3	0.2	0.0	22.4	8.3

those blackfish caught by anglers actually seeking them. Open boat and charter boat fishermen did catch some blackfish within the bay, but did not actively seek them.

The private boat fishery landed the most blackfish, usually more than all the other fisheries combined. Large numbers were taken from May through June and again from September through October. During the summer, fewer numbers were usually landed.

Although they contributed in fair amount to the bank and pier fishery in May and June, their greatest importance to this and the other fisheries was in September and October (Table 17). In October 1957, blackfish comprised nearly half the total catch of all species for bank and pier fishermen and nearly a third of that for rowboat fishermen. It appears that, although fewer blackfish were landed by the bank and pier fishery, these anglers were the most dependent upon this fish in terms of the percentage it represented in the total catch. However, there was no great difference in the proportion of the total anglers of each fishery who were seeking blackfish (Table 18).

The catch per effort of all the anglers seeking blackfish was generally good in the spring, dropped off during the summer, and usually increased

TABLE 18. PERCENTAGE OF ANGLERS IN GREAT SOUTH BAY WHO SOUGHT BLACKFISH, BY MONTH FOR DIFFERENT FISHERIES, 1956–1960

Year	May	June	July	Aug.	Sept.	Oct.
Bank and pier						
1956	....	3.1	0.0	0.0	1.1	2.2
1957	....	4.3	5.1	3.7	28.9	44.5
1958	24.8	13.4	7.4	2.8	24.4	28.6
1959	4.2	1.2	0.8	0.0	4.9	14.3
1960	25.6	18.8	11.9	3.3	11.3	22.4
Rowboat						
1956	....	0.0	0.0	0.0	0.0	3.6
1957	....	11.2	2.2	2.3	15.7	53.8
1958	71.9	17.3	7.7	0.4	7.0	22.0
1959	2.9	1.3	0.0	0.0	4.3	11.9
1960	22.7	12.0	4.2	0.8	15.9	31.2
Private boat						
1956	....	0.0	0.0	0.0	....	....
1957	....	0.0	20.3	12.7	14.9	....
1958	30.9	19.6	10.5	0.0	15.9	36.2
1959	6.1	0.0	0.0	0.0	1.0	21.1
1960	20.7	0.0	0.0	0.0	7.6	11.1

to its highest level in the fall (Table 19). Private boat fishermen usually had the best catch per effort. Bank and pier fishermen were more successful than rowboat fishermen in May, but during the rest of the year they trailed the others. There seems to have been less difference between the fisheries in catch per effort for blackfish than for either fluke or flounder; for example, bank and pier fishermen were able at times to catch blackfish at as great a rate, if not greater, than other anglers.

STRIPED BASS AND THE PRIVATE BOAT FISHERY

From 1956 through 1959 striped bass were recorded as caught only by surf fishermen. In the late summer and fall of 1960, however, private boat fishermen took large quantities of this fish; in both September and October striped bass exceeded 10 per cent of their catch of all species (Table 20). In October 1960, almost 40 per cent of the private boat anglers were seeking striped bass. Even in November, when striped bass made up less than 1 per cent of their catch of all species, more than 10 per cent of the private boat anglers were seeking them. The catch per effort of the private boat anglers who were seeking striped bass was far higher than was ever reached by surf anglers. This unusual activity in

the bay can be attributed to a large recruitment from the 1958 year class of striped bass originating in Chesapeake Bay.

Table 19. Blackfish Catch per Effort in Great South Bay, by Month for Different Fisheries, 1956–1960

Year	May	June	July	Aug.	Sept.	Oct.
			Bank and pier			
1956	...	0.9	*	*	1.8	1.8
1957	...	1.8	1.8	2.1	5.6	4.6
1958	4.1	1.0	1.2	1.8	2.4	3.7
1959	7.5	3.4	2.8	*	4.9	2.9
1960	1.6	1.6	1.1	1.4	3.6	1.6
			Rowboat			
1956	...	*	*	*	*	3.3
1957	...	4.9	3.8	3.0	6.8	5.0
1958	1.5	1.6	1.6	5.0	3.5	3.7
1959	5.9	5.1	*	*	3.0	3.6
1960	1.5	1.5	1.9	0.7	6.5	3.2
			Private boat			
1956	...	*	*	*	...	...
1957	...	*	2.8	3.5	6.7	...
1958	1.8	3.8	2.6	*	4.3	4.4
1959	3.9	*	*	*	3.0	3.7
1960	2.3	*	*	*	8.1	5.5

* No effort expended by fishermen checked.

Table 20. Catch of Striped Bass by Private Boat Anglers in Great South Bay, by Month, 1960

Item	July	Aug.	Sept.	Oct.	Nov.
Catch					
Number	753	0	8,014	16,183	.....
Per cent of total*	0.4	0.0	12.9	11.8	0.2†
Catch per effort	1.7	.....	4.3	2.2	0.3†
Anglers seeking striped bass					
Number	451	0	1,856	7,317	.....
Per cent§	1.4	0.0	11.3	39.2	10.1†

* Based on catch of all species by private boat anglers during month.
§ Based on total private boat anglers.
† In the absence of aerial counts of anglers as a basis for calculating both total anglers and total catch, values derived from data obtained during interviews were used.

THE SURF FISHERY

The surf fishery is unique in being the only one not dependent at all upon fluke and winter flounder. It is the only sport fishery that is almost entirely dependent upon striped bass, kingfish and adult bluefish (Table 21). Despite its dependence upon them, these three species constituted only a small part of the over-all catch in the Great South Bay area (Table 5); striped bass and kingfish each averaged only 0.1 per cent, and bluefish 1 5 per cent, from June through September.

TABLE 21. CATCH OF SURF ANGLERS IN THE AREA FROM JONES INLET TO FIRE ISLAND INLET, 1956–1960

Species	April	May	June	July	Aug.	Sept.	Oct.
1956							
Kingfish	....	....	0	0	16	84	....
Bluefish	....	....	0	0	164	1,080	....
Striped bass	....	....	0	0	0	388	....
Others*	....	....	0	65	8	9	....
1957							
Kingfish	....	....	201	425	768	313	....
Bluefish	....	....	25	74	255	524	....
Striped bass	....	....	10	16	62	278	....
Others*	....	....	733	230	345	41	....
1958							
Kingfish	....	273	176	488	477	352	....
Bluefish	....	0	0	0	20	10	....
Striped bass	....	228	65	51	119	111	....
Others*	....	303	195	157	125	158	....
1959							
Kingfish	0	87	280	477	379	428	198
Bluefish	0	0	0	22	18	116	20
Striped bass	0	97	62	76	71	312	267
Others*	0	83	21	48	53	43	10
1960							
Kingfish	0	105	526	1,811	115	67	126
Bluefish	0	0	14	179	1,187	337	37
Striped bass	358	348	90	223	221	612	1,438
Others*	0	120	264	511	92	0	7

* Includes blowfish, weakfish, fluke, sea bass, winter flounder, blackfish, ling and dogfish.

The surf fishery is the smallest of the sport fisheries. It is, however, the only one that has steadily increased in number of participants since 1958. Its smallness is emphasized by the proportion of surf anglers among all the anglers that fished Great South Bay and vicinity (Table 22). Only in April, September and October did this fishery consistently include more than 1.5 per cent of all the anglers. From June through September the average for surf anglers was only 1.1 per cent.

Table 22. Percentage of Anglers in All Fisheries Who Were Surf Anglers Fishing in the Area from Jones Inlet to Fire Island Inlet, 1956–1960*

Year	April	May	June	July	Aug.	Sept.	Oct.
1956	....	....	0.3	0.4	1.1	3.1	....
1957	....	....	0.8	0.7	1.5	3.4	....
1958	2.0	1.7	0.7	0.8	0.8	1.3	....
1959	1.7	1.0	0.5	0.9	0.9	2.8	2.9
1960	1.8	2.2	1.0	3.4	1.5	3.4	3.6

* 5-year average for June-September period was 1.1 per cent.

Despite the fact that the catch per effort of surf fishermen for striped bass was lower than that for any other species or fishery, most surf anglers fished for striped bass from April through December (Table 23). The rate of catch was so poor that only once during this study (October 1960) did it exceed 0.6 fish per angler per trip. In June, July, and August of 1956, and in April and December of 1959, no striped bass were caught; despite this, in four of these five months, all the surf anglers were seeking striped bass.

Striped bass catches and catch per effort increased in September. Most of those caught in the surf were taken in the fall, although there usually was no great increase in the number of anglers seeking them. The increased catch per effort can be related to an apparent increase in abundance, i.e., when more striped bass were present in the surf they were more easily caught. This is best shown by the records for 1960 (Table 23). Catch per effort during October (1.3) was more than double that for September (0.6) and more than four times that for May (0.3). Also, the number of surf anglers seeking striped bass during October (1,124) was slightly greater than that in May (1,058) or September (1,015).

During the summer, striped bass rarely comprised more than one-eighth of the surf catch, although a high percentage of the surf anglers sought them. Striped bass contributed most heavily to the surf catch during the spring up to the end of May, and during the fall and early winter beginning in September. In April, November and December, they usually were the only fish caught by surf anglers.

TABLE 23. CATCH OF STRIPED BASS BY SURF ANGLERS IN THE AREA FROM JONES INLET TO FIRE ISLAND INLET, 1956–1960

Item	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1956									
Catch									
Number			0	0	0	388			
Per cent of total*			0.0	0.0	0.0	26.3			
Catch per effort			0.0	0.0	0.0	0.6			
Anglers§									
Number			210	366	547	647			
Per cent†			100.0	100.0	75.3	53.5			
1957									
Catch									
Number			10	16	62	278			
Per cent of total*			0.8	2.0	4.9	17.8	18.3‡	100.0‡	
Catch per effort			0.1	0.1	0.1	0.3	0.3‡	0.2‡	
Anglers§									
Number			96	159	616	925			
Per cent†			16.7	27.7	49.0	74.0	78.0‡	93.3‡	
1958									
Catch									
Number		228	65	51	119	111			
Per cent of total*		27.3	12.8	12.2	12.7	20.0	67.4‡	100.0‡	
Catch per effort		0.3	0.2	0.1	0.2	0.2	0.4‡	0.2‡	
Anglers§									
Number		760	325	510	594	553			
Per cent†		80.7	74.1	71.6	67.6	76.7	92.8‡	100.0‡	
1959									
Catch									
Number	0	97	62	76	71	312	267		
Per cent of total*	0.0	36.2	17.0	12.2	13.2	34.3	54.0	83.3‡	0.0‡
Catch per effort	0.0	0.2	0.3	0.1	0.2	0.3	0.4	0.1‡	0.0‡
Anglers§									
Number	487	505	200	531	430	897	622		
Per cent†	100.0	92.9	52.8	66.4	64.6	80.9	93.3	97.4‡	100.0‡
1960									
Catch									
Number	358	348	90	223	221	612	1,483		
Per cent of total*	100.0	60.9	10.1	8.2	13.7	60.2	89.4	100.0‡	100.0‡
Catch per effort	0.6	0.3	0.2	0.1	0.3	0.6	1.3	0.3‡	tr.‡
Anglers§									
Number	606	1,059	519	1,962	660	1,015	1,124		
Per cent†	100.0	96.4	76.1	67.0	67.8	92.9	96.4	100.0‡	100.0‡

* Based on catch of all species by surf anglers during month.
§ Represents anglers who sought striped bass.
† Based on total surf anglers.
‡ In the absence of aerial counts of anglers as a basis for calculating both total anglers and total catch, values derived from data obtained during interviews were used.

Table 24. Catch of Bluefish by Surf Anglers in the Area from Jones Inlet to Fire Island Inlet, 1956–1960

Item	June	July	Aug.	Sept.	Oct.	Nov.
1956						
Catch						
Number	0	0	164	1,080	....	....
Per cent of total*	0.0	0.0	87.0	67.7	....	....
Catch per effort	0.0	0.0	0.5	13.5	....	....
Anglers§						
Number	0	0	302	80	....	....
Per cent†	0.0	0.0	41.6	66.1	....	....
1957						
Catch						
Number	25	74	255	524	....	....
Per cent of total*	2.5	10.0	17.7	37.1	43.3‡	37.1‡
Catch per effort	1.0	0.9	1.0	0.6	1.0‡	0.3‡
Anglers§						
Number	25	86	253	845	....	....
Per cent†	4.4	14.7	20.1	67.6	61.3‡	59.1‡
1958						
Catch						
Number	0	0	20	10	....	....
Per cent of total*	0.0	0.0	2.8	2.1	0.0‡	0.0‡
Catch per effort	0.0	0.0	1.0	0.4	....	....
Anglers§						
Number	0	0	20	25	....	....
Per cent†	0.0	0.0	2.3	3.5	0.0‡	0.0‡
1959						
Catch						
Number	0	22	18	116	20	....
Per cent of total*	0.0	3.6	3.3	12.8	4.0	0.0‡
Catch per effort	0.0	0.4	0.3	0.8	0.7	....
Anglers§						
Number	0	62	59	143	29	....
Per cent†	0.0	7.8	8.9	12.9	4.4	0.0‡
1960						
Catch						
Number	14	179	1,187	337	37	....
Per cent of total*	1.5	6.6	73.5	33.2	2.3	0.0‡
Catch per effort	7.0	0.6	2.1	0.4	0.7	....
Anglers§						
Number	2	299	572	772	51	....
Per cent†	0.3	10.2	58.7	70.6	6.1	0.0‡

* Based on catch of all species by surf anglers during month.
§ Represents anglers who sought striped bass.
† Based on total surf anglers.
‡ In the absence of aerial counts of anglers as a basis for calculating both total anglers and total catch, values derived from data obtained during interviews were used.

TABLE 25. CATCH OF KINGFISH BY SURF ANGLERS IN THE AREA FROM JONES INLET TO FIRE ISLAND INLET, 1956–1960

Item	May	June	July	Aug.	Sept.	Oct.
1956						
Catch						
Number	....	0	0	16	84	....
Per cent of total*	....	0.0	0.0	8.7	5.4	....
Catch per effort	....	0.0	0.0	1.0	1.1	....
Anglers§						
Number	....	0	0	16	76	....
Per cent†	....	0.0	0.0	2.2	6.3	....
1957						
Catch						
Number	....	201	425	768	313	....
Per cent of total*	....	20.8	57.1	53.3	22.2	14.6‡
Catch per effort	....	0.8	1.7	1.7	1.7	2.6‡
Anglers§						
Number	....	251	250	451	184	....
Per cent†	....	43.6	43.4	35.9	14.7	8.4‡
1958						
Catch						
Number	273	176	488	477	352	....
Per cent of total*	34.5	41.4	67.2	67.0	66.2	24.5‡
Catch per effort	0.4	0.5	1.2	1.1	1.2	0.9‡
Anglers§						
Number	682	352	407	434	293	....
Per cent†	72.4	80.3	57.2	49.4	40.6	15.8‡
1959						
Catch						
Number	87	280	477	379	428	198
Per cent of total*	32.7	77.1	76.6	70.3	47.1	40.0
Catch per effort	1.2	1.4	1.2	1.1	1.4	2.2
Anglers§						
Number	73	200	400	330	313	89
Per cent†	13.5	52.8	50.0	49.6	28.2	13.3
1960						
Catch						
Number	105	528	1,811	115	67	126
Per cent of total*	18.3	58.9	66.5	7.1	6.6	7.8
Catch per effort	2.2	2.0	1.8	1.5	1.4	1.9
Anglers§						
Number	49	262	1,010	78	47	66
Per cent†	4.5	38.4	34.5	8.0	4.3	5.7

* Based on catch of all species by surf anglers during month.
§ Represents anglers who sought striped bass.
† Based on total surf anglers.
‡ In the absence of aerial counts of anglers as a basis for calculating both total anglers and total catch, values derived from data obtained during interviews were used.

Second in importance to the surf fishery was the bluefish. Although not taken by surf fishermen in as great numbers as by other fishermen, bluefish were far more important to the surf fishery than to the other fisheries. Bluefish are sometimes first taken by surf anglers in June and occasionally are taken as late as November (Table 24). The yearly catch was quite variable in relation to their initial appearance in area waters and the month in which they were taken in the greatest numbers. In some years they were quite scarce (1958 and 1959); in others, they, at times, made up most of the surf catch (1956 and 1960). As for the striped bass, there seemed to be an increase in catch per effort when there was an apparent increase in abundance. This is shown by the records for 1960. Catch per effort during August (2.1) was more than three times that for July (0.6), and the number caught increased nearly six times (1,187 vs. 179). Also, there were nearly twice as many anglers seeking bluefish in August as in July (572 vs. 299). Had the catch per effort remained stable, the 572 anglers in August would have taken only about 350 bluefish.

Kingfish were usually the fish caught most frequently by surf anglers throughout the summer (Table 25). They were taken from May through October, with July and August usually showing the greatest catch and the greatest number of anglers seeking them. A few kingfish were also taken by bank and pier anglers, but rarely in large numbers.

Catch per effort was usually higher for kingfish than for either striped bass or bluefish, but they ranked third in preference among surf anglers. This probably was due to their relatively small average size. Also, kingfish are caught primarily with bait. Therefore, when bluefish and striped bass are being taken in numbers by anglers using artificial lures, the catch of kingfish decreases. The kingfish could probably be exploited to a higher degree by surf anglers during the summer.

When the percentages for surf anglers seeking striped bass, kingfish and bluefish during a given month are added together, they often exceed 100 (Tables 23 to 25). This is due to the fact that quite often a surf fisherman will seek more than one species. If he is using artificial lures, he may be seeking both striped bass and bluefish; if he is using bait, he may be seeking both striped bass and kingfish.

Of the "other" species taken by surf fishermen, the blowfish was the one most often caught (Table 21); however, it is generally considered a trash or nuisance fish. Weakfish are desired, but were rare catches. Winter flounder and blackfish were caught by surf anglers only in 1956 and 1957. Fluke are of little importance, although a few were caught every year (Table 7). Sea bass, ling and dogfish were caught only occasionally.

DISCUSSION

The Great South Bay area is fished by more than a quarter of a

million anglers each year. These anglers fish from private boats, open boats, charter boats, rowboats, banks and piers, and in the surf. The sport fisheries depend upon various species of fish. Fluke and winter flounder are important to the boat fisheries, which land the bulk of the approximately 1,500,000 fluke and 1,500,000 winter flounder taken annually. Snapper bluefish comprise a large proportion of the catch of bank and pier fishermen. Blackfish are important in the fall to the bank and pier fishery, and to the rowboat and private boat fisheries. The surf fishery depends upon striped bass, bluefish, and kingfish. In general, the individual fisheries rely upon different species for a successful angling season. Reduced availability or abundance of any one of these fish will affect one fishery or another at some particular season.

The over-all fishery of Great South Bay, however, is dominated by the catch of winter flounder and fluke. In years of decreased catch per effort for fluke, it is the winter flounder to which the boat fishermen turn in June and July in order to augment the poor fluke catch. In this pursuit of fluke, sport fishermen appear to ignore the snapper bluefish resource. For example, catches by rowboat anglers decline in late summer despite the fact that this is the season of snapper abundance. Private boat fishermen also continue to fish for fluke during late summer and, despite low catch per effort, do not shift their efforts to the snapper. It can be concluded that greater exploitation of the snapper population would benefit both the rowboat and private boat fisheries as well as the heavily-fished fluke population.

Similarly, surf fishermen pursue striped bass so avidly that the kingfish resource is neglected. In many summer months, most surf anglers fish for striped bass, despite the fact that kingfish are available and striped bass are not. It appears that their low catch per effort could be improved by increasing their fishing effort for kingfish during July and August. At present, the surf fishery has the fewest anglers and the lowest catch of all the sport fisheries.

The private boat fishery surpasses all others in the number of anglers and quantities of fish caught. Future angling success in Great South Bay for this fishery and the other boat fisheries depends largely upon the continuing abundance and availability of winter flounder and fluke. The bank and pier fishery relies at certain seasons upon these two species, also. However, restriction of fishing opportunity, as residential and commercial expansion continues, will most directly affect the bank and pier angler. In the present situation of rapid expansion, development of private and public bank and pier facilities is badly needed.

Catch per effort for fluke generally declines as the season progresses. Restriction of fluke fishing during May might stabilize this decline in late summer. This would not decrease the over-all catch, but it would allow the fluke to reach a larger size before being caught and it would

spread the catch more evenly throughout the summer. There would be no lack of fish for the fisherman during May because winter flounder are readily available to all anglers, and, in addition, blackfish are available to bank and pier anglers and those fishing from small boats.

Restrictions during October would deprive the angler of comparatively few fluke, and it would allow greater escapement of large adult fluke from the sport fisheries. This would release more breeders to offset the effects of poor spawning years. In October, winter flounder and blackfish are available in the same way as in May. Often bluefish are present also. Therefore, there would be no lack of fish for the anglers at that time.

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THE VASCULAR PLANTS OF SOME MARSHES CREATED FOR WILDLIFE IN SOUTHCENTRAL NEW YORK[1]

Frederick B. Emerson, Jr. Research Assistant
Department of Conservation, Cornell University[2]

ABSTRACT

A list of 139 species of naturally occurring vascular plants found growing in the water and on the moist soil about the margins of 23 wildlife marshes studied during the summer of 1960 is presented. The frequency of occurrence and abundance of each species are noted. The dominant aquatic plants and their importance are mentioned. Brief mention is made of the mesophytic species which populate the dikes of the marshes.

Studies of the vegetation of the marshes created for wildlife in this State have been included in several researches. Brumsted (1954) and Dane (1959) described some successional trends involving a few species of aquatics. Cook and Powers (1958) listed the species of plants found on two sites prior to flooding. Cursory vegetation surveys have been conducted by district game management personnel of the State Conservation Department. However, there is no complete list of the naturally occurring species of plants inhabiting the wildlife marshes. Such a list would be useful to the game biologist concerned with these marshes for it would represent the potential food and cover plants available for wildlife dependent upon such water areas.

The list of species presented in Table 1 is a contribution in this direction. It contains the naturally occurring vascular plant species observed in a detailed vegetation survey of 23 marshes in Schuyler, Tioga and Tompkins Counties during the 1960 growing season. The marshes surveyed represent about 25 per cent of the total of more than 90 marshes in the Southcentral Game Management District comprising the counties of Broome, Chemung, Chenango, Cortland, Schuyler, Tioga and Tompkins. The experience of the writer has indicated that this list will be useful over a greater area than that studied, particularly on the Allegheny Plateau in the Southern Tier region. However, species which were not recorded from the marshes studied may be abundant in other marshes of the State. For example, the aquatic horsetail (*Equisetum fluviatile*) is the dominant emergent species in one wildlife marsh in Madison County.

The 23 marshes were 3 to 10 years old, and averaged 7 years in age in 1960. Some marsh sites had no aquatic or wetland species at the time of flooding; other sites may have had a marshy portion in which

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[2] Present affiliation: The Marine Laboratory, University of Miami, Miami 49, Florida.

Table 1. Families and Species of Plants Found Growing Naturally in Water or on Moist Soil in 23 Marshes Created for Wildlife in Southcentral New York

Family and species		Status§
Equisetaceae		
Equisetum arvense	(common horsetail)	+
Osmundaceae		
Osmunda regalis	(royal fern)	−
O. cinnamomea	(cinnamon fern)	−
Polypodiaceae		
Onoclea sensibilis	(sensitive fern)	+
Dryopteris thelypteris	(marsh fern)	+
Athyrium felix-femina	(lady fern)	−
Ranunculaceae		
Ranunculus pensylvanicus	(bristly buttercup)	−
Caltha palustris	(marsh marigold)	−
Ceratophyllaceae		
Ceratophyllum demersum	(hornwort)	*
Salicaceae		
Salix lucida	(shining willow)	−
S. bebbiana	(Bebb's willow)	+
S. rigida	(tough willow)	**
S. sericea	(silky willow)	+
S. discolor	(pussy willow)	**
S. interior	(sandbar willow)	−
S. humilis	(prairie willow)	−
S. petiolaris	(slender willow)	−
S. nigra	(black willow)	−
S. fragilis	(crack willow)	+
Populus tremuloides	(trembling aspen)	−
Callitrichaceae		
Callitriche heterophylla	(water starwort)	−
C. palustris	(water starwort)	−
Aquifoliaceae		
Ilex verticillata	(deciduous holly)	+
Balsaminaceae		
Impatiens capensis	(spotted touch-me-not)	**
Corylaceae		
Alnus incana	(speckled alder)	−
Hypericaceae		
Hypericum mutilum	(dwarf St. John's-wort)	+
H. virginicum	(purple St. John's-wort)	−
H. punctatum	(spotted St. John's-wort)	+
H. perforatum	(common St. John's-wort)	+
Violaceae		
Viola cucullata	(marsh blue violet)	−
V. incognita	(white violet)	−
Cruciferae		
Rorippa islandica		−
R. sylvestris	(yellow cress)	−

TABLE 1. (*continued*)

Family and species		Status §
Polygonaceae		
Rumex britannica	(great water dock)	–
Polygonum amphibium	(water smartweed)	–
P. coccineum	(marsh smartweed)	–
P. hydropiper	(smartweed)	**
P. sagittatum	(arrow-leaved tearthumb)	**
P. arifolium	(halberd-leaved tearthumb)	–
P. persicaria	(lady's thumb)	+
P. pennsylvanicum	(Pennsylvania smartweed)	–
P. lapathifolium	(dock-leaved smartweed)	–
Primulaceae		
Lysimachia nummularia	(moneywort)	*
L. thyrsiflora	(tufted loosestrife)	–
Ericaceae		
Vaccinium corymbosum	(highbush blueberry)	–
Asclepiadaceae		
Asclepias incarnata	(swamp milkweed)	+
Boraginaceae		
Myosotis laxa	(small-flowered forget-me-not)	–
Solanaceae		
Solanum dulcamara	(European bittersweet)	+
Scrophulariaceae		
Chelone glabra	(turtlehead)	+
Mimulus ringens	(monkey flower)	+
Veronica scutellata	(marsh speedwell)	–
V. americana	(American brooklime)	–
Lentibulariaceae		
Utricularia sp.	(bladderwort)	–
Verbenaceae		
Verbena hastata	(blue vervain)	**
Labiatae		
Scutellaria lateriflora	(skullcap)	+
Prunella vulgaris	(self-heal)	+
Lycopus uniflorus	(bugle weed)	**
L. americanus	(water horehound)	+
Mentha arvensis	(field mint)	–
M. piperita	(peppermint)	–
Lobeliaceae		
Lobelia cardinalis	(cardinal flower)	–
L. siphilitica	(great lobelia)	–
Saxifragaceae		
Penthorum sedoides	(ditch stonecrop)	**
Rosaceae		
Spiraea alba	(meadowsweet)	**
Geum aleppicum	(yellow avens)	+
Rosa palustris	(swamp rose)	–

Table 1. (*continued*)

Family and species		Status§
Lythraceae		
Lythrum salicaria	(purple loosestrife)	−
Onagraceae		
Ludvigia palustris	(water purslane)	**
Epilobium coloratum	(purple-leaved willowherb)	+
E. hirsutum	(great hairy willowherb)	−
Umbelliferae		
Cicuta maculata	(water hemlock)	−
C. bulbifera	(bulb-bearing water hemlock)	−
Sium suave	(water parsnip)	−
Cornaceae		
Cornus racemosa	(gray dogwood)	+
C. alba	(red osier dogwood)	−
Rubiaceae		
Galium obtusum		−
G. trifidum tinctorium	(small bedstraw)	+
Cephalanthus occidentalis	(buttonbush)	−
Caprifoliaceae		
Viburnum dentatum	(arrowwood)	+
Compositae		
Eupatorium maculatum	(joe pye weed)	+
E. perfoliatum	(boneset)	**
Bidens cernua	(nodding bur marigold)	**
B. frondosa	(beggar's ticks)	**
B. comosa	(leafy-bracted tickseed)	+
Potamogetonaceae		
Potamogeton natans	(floating-leaf pondweed)	**
P. epihydrus	(ribbon-leaf pondweed)	−
P. foliosus		**
P. nodosus	(long-leaf pondweed)	−
P. crispus	(curly pondweed)	−
P. spirillus		−
Najadaceae		
Najas flexilis	(slender naiad)	*
Hydrocharitaceae		
Anacharis canadensis	(waterweed)	**
Lemnaceae		
Lemna minor	(common duckweed)	**
L. trisulca	(star duckweed)	*
Wolffia columbiana	(watermeal)	*
Spirodela polyrhiza	(great duckweed)	+
Alismataceae		
Sagittaria latifolia	(broad-leaved arrowhead)	*
S. rigida	(stiff wapato)	−
Alisma plantago-aquatica	(water plantain)	**
Sparganiaceae		
Sparganium eurycarpum	(giant burreed)	−
S. americanum		**

TABLE 1. (*continued*)

Family and species		Status§
Typhaceae		
Typha latifolia	(broad-leaved cattail)	**
T. angustifolia	(narrow-leaved cattail)	–
Araceae		
Acorus calamus	(sweet flag)	–
Pontederiaceae		
Heteranthera dubia	(water star grass)	–
Iridaceae		
Iris versicolor	(blue flag)	+
Juncaceae		
Juncus macer	(path rush)	+
J. marginatus		+
J. acuminatus		+
J. effusus	(soft rush)	**
J. nodosus		–
Cyperaceae		
Scirpus atrovirens		+
S. cyperinus	(wool grass)	**
S. validus	(soft-stem bulrush)	–
Eleocharis acicularis	(needle rush)	**
E. palustris	(creeping spike rush)	*
E. obtusa		**
E. elliptica		–
Cyperus strigosus		–
Dulichium arundinaceum	(three-way sedge)	–
Carex stipata		+
C. scoparia		**
C. cristatella		+
C. crinita		+
C. comosa		+
C. lurida		**
C. vulpinoidea	(fox-tail sedge)	**
C. hystricina		–
C. lupulina		–
C. retrorsa		–
C. riparia		–
Gramineae		
Leersia oryzoides	(rice cutgrass)	**
Agrostis stolonifera	(bent grass)	**
Glyceria maxima grandis	(reed meadow grass)	**
G. acutiflora		–
G. striata		–
Echinochloa pungens		+
Phalaris arundinacea	(reed canary grass)	–
Orchidaceae		
Spiranthes cernua	(autumn ladies' tresses)	–

§ For explanation of the symbols, see text.

such species were thriving before flooding. Unfortunately, there is very little recorded information available describing the marsh sites before flooding. Thus, in most cases it is not known which species were present before flooding and which came in after flooding.

The list includes all of the species found growing in the water and on the moist soil about the margins of the marshes. Thus, species which are normally considered terrestrial are listed. Woody plants, e.g., *Salix* spp., *Alnus incana*, *Spiraea alba*, *Ilex verticillata*, and *Viburnum dentatum*, which have demonstrated the ability to tolerate flooding for a number of years, are included. The taxonomic interpretations are those found in the checklist by Clausen (1949). Where possible, common names frequently found in the literature are listed.

Following each species name in Table 1 is a symbol designating frequency of occurrence and abundance. The 139 species observed fell into four groups:

1. 66 species infrequently found in the marshes and occurring sparsely where found; indicated by a minus sign (—)
2. 36 species frequently encountered, but occurring sparsely; indicated by a plus sign (+)
3. 7 species which were abundant in one or a few marshes but not frequently encountered in the marshes in general; indicated by an asterisk (*)
4. 30 species which were both frequently encountered and at least sometimes abundant when encountered; indicated by a double asterisk (**)

A species was arbitrarily rated as frequently occurring if it was encountered in at least 30 per cent of the marshes studied. The terms sparse and abundant were for the most part subjective appraisals. However, quadrat counts were made in stands of varying density for each of several species of common marsh plants; and four density classes (abundant, common, sparse, and very sparse) have been proposed and described for these species by the author elsewhere (Emerson, 1961).

Eight species of aquatic plants were common in the marshes studied: *Eleocharis obtusa*, *Leersia oryzoides*, *Ludvigia palustris*, *Typha latifolia*, *Potamogeton foliosus*, *Lemna minor*, *Sparganium americanum*, and *Alisma plantago-aquatica*. The emergents, *Leersia*, *Typha*, and *Sparganium*, provide fair to good cover, and *Potamogeton*, *Lemna*, and *Leersia* are good waterfowl foods. *Leersia*, *Ludvigia*, and *Eleocharis* are important pioneers which hold the soil of the wave-swept margins and keep the finer, nutrient-bearing soil particles from being carried away into deeper water. *Potamogeton* and *Ludvigia* harbor invertebrate animals important as food for ducklings and other organisms.

The mesophytic vegetation of the dike and periphery of a marsh also contributes cover. Many of the dikes have been planted with legumes and grasses which are used by ducks as cover for preening and other activities. The species on the dikes and shorelines of the marshes represented the upland flora which remained unchanged when the site was flooded. Composites were well represented by goldenrods (*Solidago*), asters (*Aster*), thistles (*Cirsium*), daisies (*Chrysanthemum*), and daisy fleabanes (*Erigeron*). Timothy (*Phleum pratense*), golden foxtail (*Setaria lutescens*), and orchard grass (*Dactylis glomerata*) were among the grasses commonly encountered. The family Rosaceae was represented by cinquefoils (*Potentilla*), strawberry (*Fragaria*), blackberries and raspberries (*Rubus*), cherries (*Prunus*), apple (*Pyrus*), and thornapples (*Crataegus*). Some of the legumes found were birdsfoot trefoil (*Lotus corniculatus*), alfalfa (*Medicago sativa*), black medic (*Medicago lupulina*), clovers (*Trifolium*), and sweet clovers (*Melilotus alba* and *M. altissima*). Over 125 species representing 46 families were found on the dikes of the 23 marshes during the 1960 growing season.

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DEPTH DISTRIBUTION OF LAKE TROUT AND ASSOCIATED SPECIES IN CAYUGA LAKE, NEW YORK[1]

James P. Galligan Chief, Division of Fisheries
Connecticut Board of Fisheries and Game[2]

ABSTRACT

The depth distribution of lake trout in Cayuga Lake was studied during the summer, fall and winter of 1950–51. The lake was divided into five sections. Sampling gear consisted of 500-foot standard gangs of gill net. During the summer, the greatest population density of lake trout was found at the 80 to 100-foot depth interval, but they were fairly abundant at depths of 40 to 140 feet. The greatest numbers seemed to prefer the zone between the 45° and 55° (F.) isotherms. Depth distribution was somewhat variable in the fall period. There was a decided inshore movement with the progression of the spawning season and the dropping of surface temperatures to 50° F. Fewer trout were caught in the winter months; their mean depth then was 60 feet. No difference in depth preference by size classes could be detected.

Data were also obtained on the horizontal and vertical distribution of associated species. Alewives were distributed generally throughout the lake and their depth range was such that they were readily available as forage for lake trout at all times. The catch of smelt was quite low but did increase in the winter period with the onset of their spawning period. In summer, the greatest numbers were taken on the flats at the northern and southern ends of the lake in 100 to 120 feet of water. Ciscoes seemed to occupy the deepest water in the lake as most were taken between 120 and 160 feet during the summer. Although netting efforts were not extensive in the extremely deep waters of the lake (200 to 400 feet), there is good evidence that neither lake trout nor the other deepwater fishes inhabit to any appreciable extent the vast bottom area of Cayuga Lake below the 200-foot contour.

Cayuga Lake, situated in central New York, is one of the unique Finger Lakes group. All of these lakes are oligotrophic in nature and have the physical and chemical qualifications to support substantial populations of lake trout and other deepwater fishes. General descriptions of the limnology and fish fauna of Cayuga Lake have been given in earlier publications (Birge and Juday, 1914; Webster, 1954). Webster *et al.* (1959) summarized the early history of the lake trout (*Salvelinus namaycush namaycush*) fishery in Cayuga Lake and pointed out how this lake differed from its sister lakes in having a significantly smaller lake trout population. They also summarized the cooperative efforts by

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[1] Derived from M.S. thesis presented to the Graduate School, Cornell University. Appreciation is expressed to Dr. Dwight A. Webster, Professor of Fishery Biology at Cornell University, for his many suggestions in design and direction of the study and for his critical review of the manuscript. Dr. D. C. Chandler and G. S. Bradshaw, formerly of the Department of Entomology and Limnology at Cornell University, made subsurface temperature data available. C. W. Lyons, fishery technician at the Cornell Experimental Fish Hatchery, and several graduate and undergraduate students in fishery biology assisted with the field work. Particular thanks is extended to Roland Wigley, Kendall Warner and G. S. Bradshaw, who assisted with winter netting operations. Dr. J. W. Wells and Philo Wilson of the Geology Department examined bottom deposits from the lake and provided general information regarding the geology of the Cayuga Lake basin. Douglass Payne of the Cornell Department of Conservation prepared the figures.

[2] While doing the field work the author held the position of research assistant with the New York State Conservation Department.

fishery workers of Cornell University and the New York State Conservation Department, which resulted in increasing the trout population to its present high density level. Fishing success for lake trout is now considered good to excellent. This paper presents additional data on the depth distribution of lake trout and associated species.

The main purposes of fish distribution studies are obvious. They make a general contribution to knowledge of the life histories of the species present, and they indicate the preferred habitat of juvenile and adult fish at different times of the year. They also provide information on the location of the main spawning areas and the other species frequenting the spawning grounds. All of these are important factors in lake trout management. Information obtained from distribution studies could be applied to future systematic collections of lake trout and associated deep-water forms.

Also, in this study, it was considered desirable to determine the dispersal pattern of lake trout fingerlings and yearlings from stocking sites.[3] Knowledge of the distribution of lake trout was also considered essential to complete interpretation of survival data. Still another objective was to set up standardized sampling methods which might apply to the collection of lake trout in other Finger Lakes and perhaps in other waters of New York where this species is a recognized or favored game fish. Finally, it afforded the opportunity to obtain information on associated species which serve as forage for or are potential competitors of lake trout. In Cayuga Lake, these species include the landlocked alewife (*Alosa pseudoharengus*), smelt (*Osmerus mordax*) and cisco (*Coregonus artedi*).

The alewife has often been considered a desirable forage fish. Odell's (1934) work on its life history and ecological relationships in Seneca Lake is the only detailed study on this species in the Finger Lakes. The smelt, since its sudden increase in 1946, probably has occasioned more total fishing effort than any other species in Cayuga Lake; it is taken in the tributary streams during the spring spawning run. The cisco is not as abundant in Cayuga Lake and little, if any, time is spent fishing for it; its role in the economy of the lake is not known. Brief comment is also made on other species such as smallmouth bass (*Micropterus dolomieui*), yellow perch (*Perca flavescens*) and rock bass (*Ambloplites rupestris*) that were collected in the course of sampling.

MATERIALS AND METHODS

Much of what would normally be covered under this heading has been reported in detail in previous works (Galligan, 1951; and Webster *et al.*, 1959) and, to avoid duplication, will not be repeated here. This includes background material from 1945 to 1957 on stocking (numbers,

[3] Dispersal of hatchery-reared lake trout was discussed in greater detail by Webster *et al.* (1959).

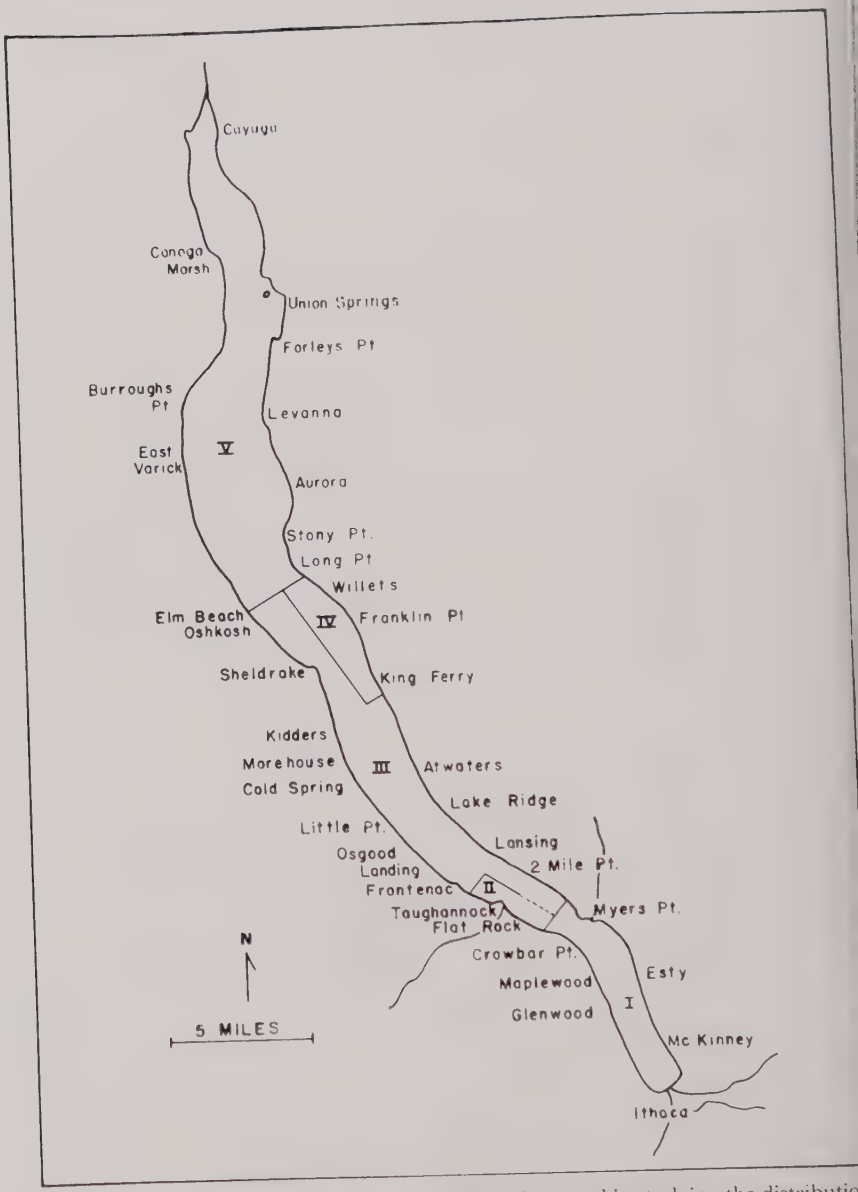

Figure 1. Map of Cayuga Lake showing five sections used in studying the distributio of lake trout and associated species.

sizes and sites), fin clipping, sampling design, description of standar gangs of gill net, tagging methods and details concerned with processir the fish captured.

In setting up the sampling design, the lake was divided into fi sections (Figure 1). Two relatively small areas in the vicinity of Frankl

and Taughannock Points were sufficiently unique (the trout concentrations at certain seasons of the year were much greater there than in other areas of the lake) to warrant being considered individually. One of these, Section II, was known to be the main spawning ground for lake trout in the fall and also is the area where the majority of the lake trout plantings have been made. The other, Section IV, was known to have a concentration of large trout during the summer. The three other sections were larger and more or less arbitrarily selected.

Section I, at the extreme southern end of the lake extends from Willow Point south. This section differs from the others in that most of the main tributaries of the lake enter there. Cayuga Inlet, Fall Creek, Cascadilla Creek and Six Mile Creek all join in the city of Ithaca and enter as one stream. Formerly, extensive shallows and swampland existed at this end. The 100-foot contour crosses in the vicinity of McKinney. A 300-foot depth contour crosses about opposite Glenwood and the 350-foot one off Myers Point. For further details regarding bottom contours and hydrographic data see Birge and Juday (1914).

Section II has one large tributary entering at Taughannock Point. For the most part, the dropoff is rather abrupt along this shoreline, particularly off Taughannock Point. The area known as Flat Rock, just south of Taughannock Point, is a broad, shallow shelf of limestone ledges. It is a popular locale for lake trout fishermen in the early spring, and it is also a wintering area for smallmouth bass.

Section III is the long central basin extending from Willow Creek and Mile Point north to Elm Beach. This section contains the greatest amount of deep water and is lake trout habitat throughout. A 400-foot contour extends from Frontenac to Willets. The greatest depth found is 435 feet in mid-lake off Kidders.

Some variations occur in the habitat in Section IV. This area has a concentration of large trout during the summer and differs from other parts of the lake in that fishermen have consistently reported the presence of sulphur springs offshore near Franklin Point. Also, the bottom deposits there contain a generous portion of grit extending much farther out into the lake (275 feet) than in other areas where only mud is found beyond 50 feet of depth. This unique situation is described in more detail under Discussion.

Section V, which extends north from Elm Beach and Long Point, contains an area of extensive shallows above Union Springs. The area from Canoga marsh north is primarily warm-water habitat with extensive weed beds and is inhabited by such species as largemouth bass, northern pike, chain pickerel, yellow perch, common bullhead and longnosed gar. The 100-foot contour crosses the lake to the south of Farleys Point and the 300- and 350-foot contours cross opposite Aurora and Stony Point, respectively.

Data were gathered during 1950–51. The lake was sampled extensively during the summer period. This included netting as far toward its northern and southern ends as was considered lake trout habitat. Insofar as possible, the same sites were again sampled in the fall and winter. The sampling seasons were determined by the fall spawning period. The summer period extended from June 28 to September 8; the fall period from September 20, when adult lake trout were first taken on the spawning grounds at Taughannock Point, until November 19, the last date of catch at that site; and the winter period from December 6 to March 30.

The standard experimental gangs of gill net used consisted of five 100-foot sections of 1½- to 3½-inch stretched mesh plus six 10-foot sections of 1¼-inch mesh. One of these 10-foot sections of small mesh was placed between each of the five larger mesh sizes and at each end. The sequence of the various mesh sizes for the 100-foot sections in a gang was assigned at random as follows: 2, 1½, 3, 2⅝ and 3½ (inch). Five such gangs were fished during the summer, fall and winter periods.

A few nets of large-sized mesh (5- and 6-inch) were fished during the summer off Franklin Point (Section IV) and during the fall at Taughannock Point (Section II) to capture large trout then concentrated at these points. Table 1 summarizes the total sampling effort and the catch of lake trout during the entire study period.

Table 1. Total Sampling Effort and Catch of Lake Trout in Cayuga Lake from June 1950 to March 1951

Season	Total feet of net set	Standard gangs set		5-to 6-inch mesh nets set *		Lake trout captured
		Feet	Number	Feet	Number	
Summer....	28,600	27,400	50	1,200	3	254
Fall.....	19,800	13,500	26	6,300	21	262
Winter.....	13,540	12,940	23	600	2	21
Total....	61,940	53,840	99	8,100	26	537

* During the summer 400-foot nets were used; during the fall and winter, 300-foot nets.

To determine the depth distribution of the fishes captured, three soundings were made along each gill net set; one at each end and a third approximately 200 feet from the inshore end. Points for sounding were marked by the boat operator with dowel buoys weighted at one end (3 feet long by ½ inch in diameter) which offered little resistance to the wind and current. After the gang was completely run out, soundings

were made at the locations of the buoys. With a heavy wind or strong current more or less drift was encountered, but probably not enough to seriously affect the applicability of the soundings obtained. The gill net floats were all numbered and thus the depth at which each specimen was captured could be plotted. Then an enumeration was made of the number of fish captured within each 20-foot interval of depth. To make these data comparable, this figure was divided by the number of nets fished at that depth. This was done for each monthly sample. This treatment permitted plotting indicies of density (multiplied by 10 for convenience) of the lake trout population by the use of frequency polygons.

Isotherms were constructed from 200-foot bathythermograph readings taken twice a week throughout the summer and fall at one station off the bay south of Taughannock Point (500 yards offshore over 250 feet of water). It is not known how representative these records were of the rest of the lake but they were considered sufficient for this study. Curves were smoothed by a moving average of three to lessen the influence or effects of temperature seiches which occur commonly in Cayuga Lake. All surface temperatures were obtained by the writer using a Weksler armored thermometer and reading to the nearest degree Fahrenheit. This complete surface temperature series was recorded by Galligan (1951, Appendix III).

DISTRIBUTION OF LAKE TROUT

The data obtained are presented according to the three seasonal periods covered by the study. They are analyzed primarily in relation to the vertical distribution of lake trout.

Summer Period

The summer catch of 227 lake trout in 50 overnight sets of the standard gangs represented 4.5 trout per set. The catch per unit of effort for trout caught (2) per 60 feet of 1¼-inch-mesh net fished in 50 overnight sets was 0.04, and that for trout caught (27) per 100 feet of large-sized-mesh (5- and 6-inch) nets fished in three overnight sets off Franklin Point was 2.25. The total catch of all species taken in the standard gangs during the summer period is shown in Table 2.

The vertical distribution for the combined catch of lake trout during the summer period is shown in Figure 2. Lake trout of all sizes were found predominantly between 40 and 100 feet and were common down to 180 feet in Cayuga Lake at this season. The depth at which the greatest density occurred was 80 to 100 feet. Eaton (1928) found the average depth at which 150 lake trout in the Finger Lakes were taken was 85 feet. This coincides with the greatest densities for June, August and September in this study. The maximum depth at which lake trout were taken in 1950 was approximately 265 feet, and in 1949 (Bentley, 1950) it was about 250 feet.

Table 2. Total Catch in 50 Overnight Sets of Standard Gangs in Cayuga Lake during the Summer Period, 1950*

Mesh size (inches)	Lake trout	Alewife	Cisco	Smelt	Rainbow trout	Yellow perch	Smallmouth bass	Rock bass	Common sucker
1¼....	2	840	0	25	0	1	0	0	0
1½....	8	142	2	18	0	3	0	1	0
2.....	42	29	30	8	0	47	0	1	0
2⅝....	59	11	53	13	2	8	0	0	0
3.....	71	5	38	7	4	5	1	0	1
3½....	45	1	9	5	6	0	4	3	5
Total..	227	1,028	132	76	12	64	5	5	6

* Also caught were: one trout-perch and one bullhead in the 1¼-inch-mesh nets; two lampreys (not attached) in the 3-inch-mesh nets; and one brown trout in the 3½-inch-mesh nets.

It is evident that a gradual increase in the depth at which lake trout were most often found accompanied an increase in water surface temperature and depression of the isotherms. During the summer, lake trout were captured most frequently in the zone between the 45° and 55° (F.) isotherms. In Cayuga Lake, thermal stratification does not become well marked and stabilized until midsummer when the thermocline is located at around 40 to 60 feet (Birge and Juday, 1914; Burkholder, 1931; Bentley, 1950; and unpublished data on file in the Department of Conservation at Cornell University). Violent temperature seiches are common, however.

The greatest population density of lake trout occurred at depths of between 20 and 60 feet in July and between 80 and 100 feet during the other summer months. Their occurrence inshore in July coincided with the presence of alewives spawning in shallow water at this time. Odell (1934) found the peak of spawning activity among alewives in the Finger Lakes to occur during the first two weeks in July. The vertical distribution of this species in Cayuga Lake is treated later in this paper. Lake trout may enter relatively shallow water to prey on these concentrations of forage fish even though the water temperatures are somewhat warmer than are normally preferred by the lake trout. Dymond (1928) found this to occur in Lake Ontario, as fishermen reported two weeks of good trout fishing inshore in the summer when alewives were spawning.

As the isotherms underwent a general downward trend from June on, the taper from maximum density at 90 feet became more abrupt

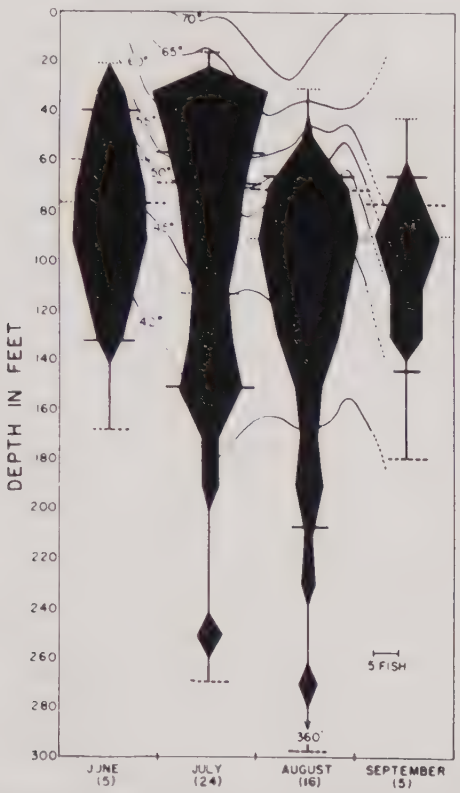

Figure 2. Relative density of the lake trout population at various depths in Cayuga Lake during the summer as indicated by their frequency in netting samples in 1950. Number of sets of standard gangs are given in parentheses for each month. Position of nets during each month is shown as follows: minimum and maximum depths at inshore end (. . . . .); minimum and maximum depths at outside end (_ _ _); mean depths for inshore and outside ends (_____).

toward the shallower side, particularly in August and September. On the other hand, there was a more gradual taper in July, August and September on the side toward the greater depths (Figure 2).

The lake trout catch was divided into four size classes to determine if differences existed in the depth distribution of large and small fish. Data for each size class were treated in the manner previously described for the total catch. The results suggest no marked difference (Figure 3). Fifteen trout were taken at depths greater than 180 feet during the sampling period and only two of these were less than 20 inches in length. It is likely that failure to capture numbers of small lake trout (8 inches long or less) in this and other investigations was probably due to their not being vulnerable to the gear used rather than to a lack of sampling of preferred habitat.

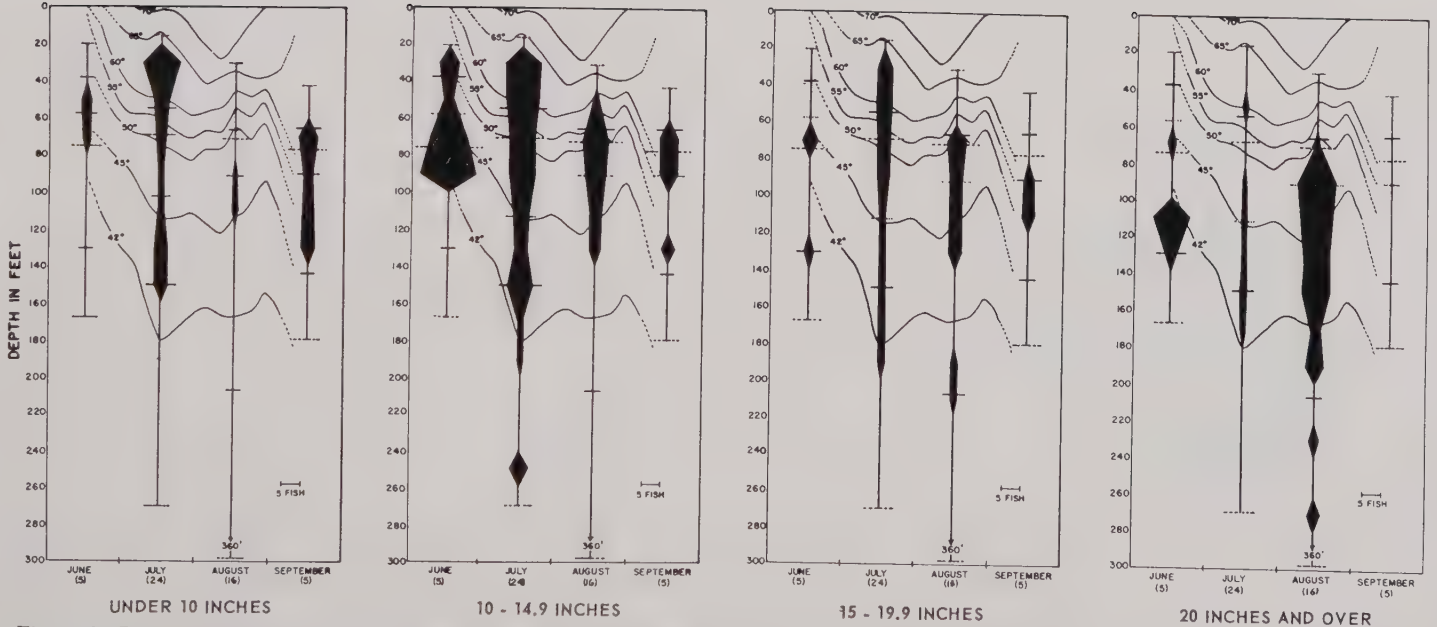

Figure 3. Relative densities of four size classes of lake trout at various depths in Cayuga Lake during the summer as indicated by their frequency in netting samples in 1950. See Figure 2 for explanation of symbols.

Martin (1952), in a similar study of lake trout distribution in two Algonquin Park (Ontario) lakes, found that smaller trout definitely had a deeper distribution in midsummer than did the larger fish. He stated that the 8° (C.) isotherm seemed to separate the zone occupied by fish larger than 12 inches from that used by smaller fish. Eschmeyer (1956), on the other hand, found that, in Lake Superior, trout of age group 0 occupied shallower water in the summer and early fall than did those of age groups I or II. Young-of-the-year trout were collected most frequently at the 60 to 85-foot depth interval, and the 1- and 2-year-old fish at 180 feet. As for temperature preferences of the Lake Superior trout, young-of-the-year fish were found most often in the range between 42° and 63° F., whereas the 1- and 2-year-olds were in somewhat colder water in the 39° and 53° F. range. Royce (1943) made special effort to capture small, juvenile lake trout in Keuka Lake (New York) and took several at approximately 100 feet. In another restricted area, at depths of 40 to 70 feet, he took both yearlings, 2-year-olds and adults.

Fall Period

Considerable movement of the adult lake trout population took place in the fall. A large concentration of breeding fish was found at Taughannock Point. On September 8, gill net sets off Taughannock yielded no adult trout; however, 17 were taken in two sets on September 20. A total of 47 overnight gill net sets were made in the fall period. In 26 of these, standard gangs were employed, while in the remainder 300-

TABLE 3. TOTAL CATCH IN 26 OVERNIGHT SETS OF STANDARD GANGS IN CAYUGA LAKE DURING THE FALL PERIOD, 1950*

Mesh size (inches)	Lake trout	Alewife	Cisco	Smelt	Rainbow trout	Yellow perch	Smallmouth bass	Rock bass	Common sucker
1¼....	4	65	0	19	0	6	0	2	0
1½....	3	22	1	22	0	2	0	0	0
2.....	10	2	2	10	0	15	0	4	0
2⅝....	20	12	9	10	1	5	1	6	1
3.....	32	0	6	8	0	3	2	6	0
3½....	32	0	0	4	0	4	3	5	5
5and6.	161	0	0	0	0	0	0	0	0
Total..	262	101	18	73	1	35	6	23	6

* Also caught were: one lamprey and three spottail minnows in the 1¼-inch-mesh nets; and two lampreys in the 1½-inch-mesh nets.

foot gangs of 5- and 6-inch mesh were used. The 26 sets of standard gangs were distributed throughout the lake with the intent of sampling areas sampled in the summer period. The catch of all species according to the various mesh sizes is shown in Table 3. The standard gangs took 101 lake trout for a catch of 3.9 per set as compared with 4.5 per gang for the summer period. This difference was insignificant; $t = 0.79$ when the data were normalized by $\sqrt{x + 0.5}$ transformation.

Few small lake trout or species other than trout were taken on the spawning grounds, although many situations have been recorded in which other fishes, particularly small lake trout, have been serious predators of lake trout eggs. The few common suckers taken on the spawning grounds contained no trout eggs and only one 6.5-inch lake trout was found to have eaten eggs. Atkinson (1931) found the common sucker (*Catostomus commersonnii*) and common bullhead (*Ameiurus nebulosus*) to feed extensively on lake trout eggs in Commandant Lake in Quebec. In Seneca Lake 10 juvenile lake trout, 9 to 13 inches long, were taken in standard gangs on the spawning grounds at Peach Orchard Point on October 3, 1950; six of these fish had been feeding extensively on lake trout eggs.[4]

The depth distribution of lake trout in the fall period was treated in a manner similar to that of the summer catch except that there was no breakdown of size classes of trout. Also, the isotherms were not included due to the small number of temperature series taken each month and the marked irregularity of the curves owing to temperature seiches.

Figure 4 shows the relative densities of the trout population as reflected by the distribution of those captured in standard gangs at various depths. The frequency polygons suggest greater irregularity than was encountered in the summer catch. For September, the catch and distribution picture is restricted because only two sets were made and they were in water not much over 120 feet deep. In October, the lake trout were found with almost equal frequency between 60 and 120 feet. In November, there was a decided inshore movement accompanied by the surface temperature dropping below 50° F. where it stayed for the remainder of the winter.

There is no evidence that lake trout in Cayuga Lake spawn in shallow water. When trout were first taken on the spawning grounds at Taughannock Point, they were at depths to 240 feet with the majority occurring between 100 and 150 feet. As the spawning season progressed and the water cooled, the trout were taken closer to shore in shallower water. Trout taken at Frontenac occupied much deeper water while in spawning condition than those a short distance to the south at Taughannock. This situation persisted late in the season. When the fish at Taughannock had moved into depths of 30 to 50 feet, those at Frontenac were found at 100- to 175-foot depths.

[4] W. G. Bentley, personal communication, 1950.

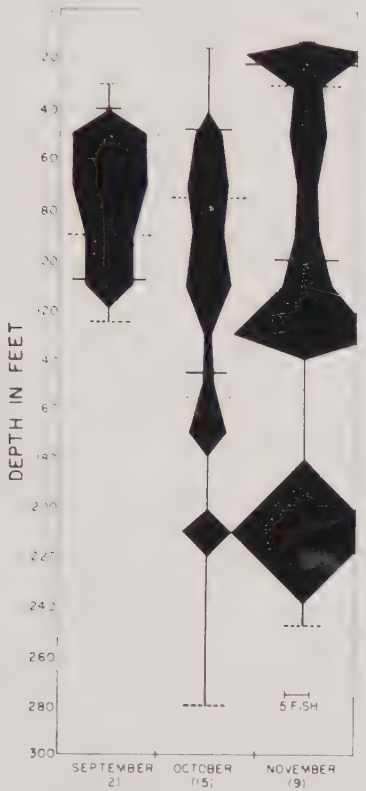

Figure 4. Relative density of the lake trout population at various depths in Cayuga Lake during the fall as indicated by their frequency in netting samples in 1950. See Figure 2 for explanation of symbols.

Royce (1943) described in great detail the type of bottom over which lake trout spawn, with particular reference to Seneca Lake. The bottom is coarse gravel scoured clean by subsurface currents. These strong currents are undoubtedly the result of seiches caused by the wind. Strong currents have been observed off Taughannock Point in Cayuga Lake as they have off Peach Orchard Point in Seneca Lake.

Winter Period

The winter sampling period extended from December 5, 1950 to March 30, 1951. During this time, 25 overnight gill net sets were made. Two of these were 300-foot gangs of large-sized-mesh nets which were set at Taughannock Point and Frontenac on December 5. These two sets took no fish, indicating that the spawning population had moved out of the area after the previous set on November 17 when three gangs totaling 900 feet took 46 trout. Table 4 shows the total catch according to the various mesh sizes for the other sets. The small catch of 21 lake

Table 4. Total Catch in 23 Overnight Sets of Standard Gangs in Cayuga Lake during the Winter Period, 1950–51 *

Mesh size (inches)	Lake trout	Alewife	Cisco	Smelt	Rainbow trout	Yellow perch	Rock bass	Northern pike	Common sucker
1¼....	5	16	0	48	0	3	0	0	0
1½....	0	19	0	34	0	4	1	0	0
2.....	3	6	1	11	0	4	0	0	0
2⅝....	4	3	2	1	0	0	0	2	0
3.....	3	0	3	0	1	0	1	1	2
3½....	6	0	0	2	0	1	0	2	2
Total..	21	44	6	96	1	12	2	5	4

* Also caught were: one lamprey and one spottail minnow in the 1¼-inch-mesh nets; and one gar pike in the 2-inch-mesh nets.

trout was about one-tenth of the summer catch and was taken with about half the effort. The catch per standard gang of 0.9 contrasted sharply with those of 4.5 for the summer period and of 3.9 for fall.

The winter catch fell below what had been expected on the basis of previous netting and reports of spearing trout in shallow water. It appears certain that the effort expended did not sample the lake trout population in the same manner as during the summer and fall periods. Presumably, the reduction in catch was due to a change in habitat and/or habits of the fish rather than to an actual decline in the population. It is probably not coincidence that the winter catch of alewives and ciscoes showed a concurrent decline.

The depth range fished by gill nets in the winter period was from 8 to 230 feet. Lake trout were recorded from 12 to 174 feet. The mean depth at which trout were found was about 60 feet. The limited number of specimens does not warrant graphic presentation.

A note may be added relative to the depth distribution of a planting of 8,000 yearling lake trout on March 17, 1951. The planting was made, as usual, from shore at Taughannock Point. Just prior to stocking, standard gangs were set a half mile to the north and south of Taughannock and at the planting site. Five of the newly stocked yearlings were taken in the net set at the planting site. These five fish were taken in 1¼-inch mesh at depths ranging from 20 to 130 feet; three occurred between 90 and 100 feet. No fish other than planted lake trout were taken.

DISTRIBUTION OF ASSOCIATED SPECIES

Inasmuch as information on the seasonal distribution of lake trout

was the primary objective of the study, the same five sections are used to discuss the distribution of associated species. Probably the two small sections (II and IV) could be disregarded for the non-trout species; however, they are included for comparative purposes. Three other species, the alewife, smelt and cisco, were prevalent in the deep waters of Cayuga Lake.

Alewife

It has been shown in other studies (Galligan, 1951; Webster *et al.*, 1959) that the alewife plays an important role in the diet of lake trout in Cayuga Lake; therefore, its distribution is described and compared with that of lake trout. The peak of the spawning period for alewives in the Finger Lakes occurs during the last week of June and the first week of July, and for a month before and after this peak adult fish can be observed in the evenings close to the shore in large schools throughout the entire lake.

The catch of alewives by gill nets in 1950–51 amounted to 1,028 during the summer period, 101 during the fall and 44 during the winter. Nets of 1¼-inch mesh were used primarily to determine the distribution of alewives and were responsible for 82 per cent of the catch during the summer. The 840 alewives captured in nets of this mesh size represented a density of 35 fish per 100 feet of net. There was a progressive decline in the catch as the mesh size increased (Tables 2, 3 and 4). The 1½-inch-mesh nets took fish (2.8 per 100-foot net), but those having larger mesh sizes captured relatively insignificant numbers.

Horizontal Distribution The catch of alewives with respect to their frequency in the five sampling sections during the three seasonal periods is summarized in Table 5. Cursory inspection suggests that the large middle basin of the lake (Section III) had a much larger population than, for example, the northern portion of the lake (Section V) during the summer. Actually, this was not the case, but may simply have been due to sampling variation in 1950 or atypical behavior of the fish. Webster *et al.* (1959, Table 28), using collection data for the six-year period 1950–1955, show that alewife distribution was quite general throughout the entire lake. Actually, Section V yielded the greatest catch of alewives over the longer sampling period.

Table 5 also shows a drastic decline in the alewife catch as the season progressed. This may have been due to a more pelagic habit, but there probably was considerable natural mortality following spawning.

Vertical Distribution Examination of Figure 5 indicates that the greatest density of alewives during the summer occurred in June and July in relatively shallow water (40 to 80 feet). Data provided by D A. Webster of Cornell University relative to density in shallow water in 1945, based on 27 overnight sets (65 nets), are shown in Figure 6. The

Table 5. Relative Frequency of Alewives, Smelt and Ciscoes in the Netting Samples from the Different Sections of Cayuga Lake during Each Season, 1950–51

Section	Standard gangs set	Alewives caught		Smelt caught		Ciscoes caught	
		Number	Frequency	Number	Frequency	Number	Frequency
Summer							
I.....	11	155	14.09	34	3.09	27	2.45
II.....	8	127	15.88	4	0.50	10	1.25
III.....	13	612	47.08	14	1.08	24	1.85
IV.....	10	89	8.90	2	0.20	15	1.50
V.....	8	45	5.62	22	2.75	56	7.00
Total....	50	1,028	20.56	76	1.52	132	2.64
Fall							
I.....	5	18	3.60	29	5.80	5	1.00
II.....	3	9	3.00	2	0.67	2	0.67
III.....	11	58	5.27	24	2.18	11	1.00
IV.....	3	5	1.67	4	1.33	0	0.00
V.....	4	11	2.75	14	3.50	0	0.00
Total....	26	101	3.88	73	2.81	18	0.69
Winter							
I.....	4	11	2.75	3	0.75	0	0.00
II.....	11	33	3.00	39	3.55	2	0.18
III.....	3	0	0.00	13	4.33	2	0.67
IV.....	5	0	0.00	41	8.20	2	0.40
V.....	..	..	....	..	....	..	....
Total....	23	44	1.91	96	4.17	6	0.26

maximum catch was 394 fish in about 5 feet of water. In 1945, there was a gradual increase in the catch from June to the end of July in less than 50 feet of water. In August, the drop in catch was abrupt with a relatively insignificant number being taken from September to November.

In 1950 the greatest density for alewives during July, August and September occurred at about 70 feet, while that for lake trout occurred in the depth interval just below it at 90 feet. As previously pointed out, the high density of lake trout in July, at a depth of 20 to 60 feet, coincided with a relatively high concentration of alewives at the same depth.

In October and November, there was a definite trend among the alewives toward greater depths (Figure 7). This was not followed by the lake trout, however. A similar trend among alewives was noticed

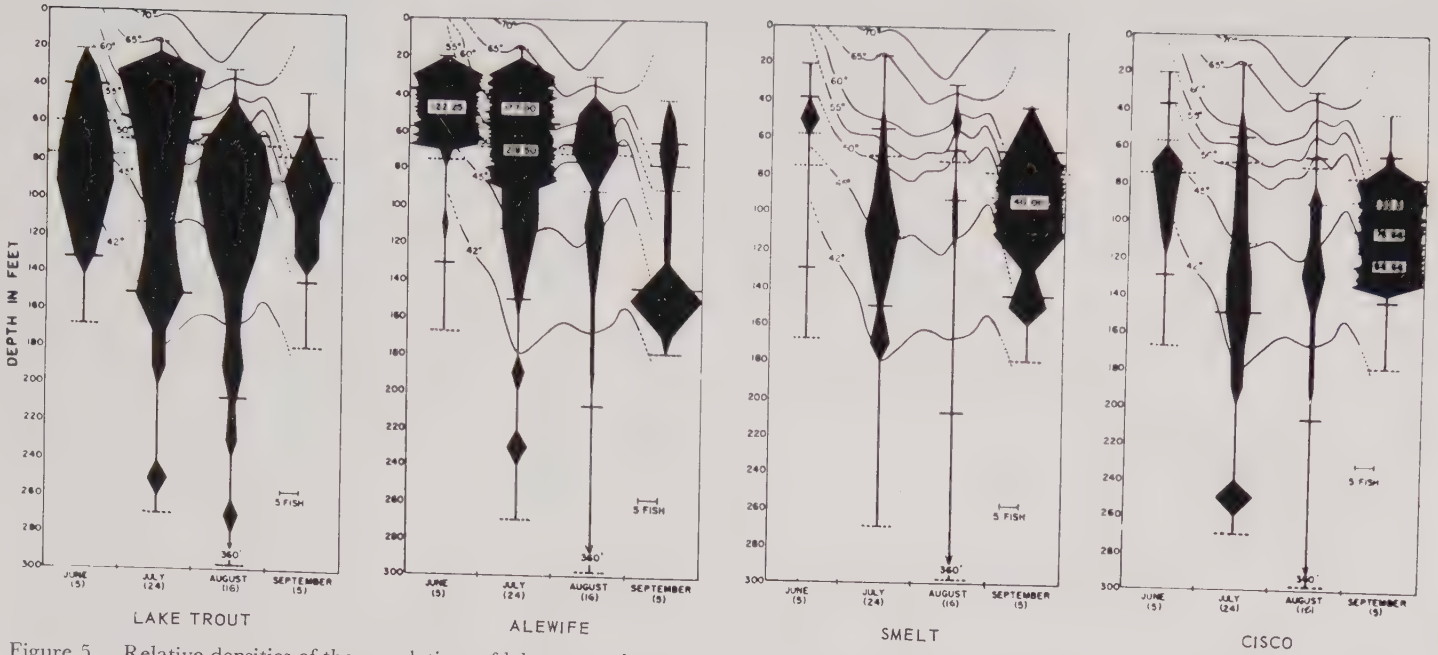

Figure 5. Relative densities of the populations of lake trout, alewives, smelt and ciscoes at various depths in Cayuga Lake during the summer as indicated by their frequency in netting samples in 1950. See Figure 2 for explanation of symbols.

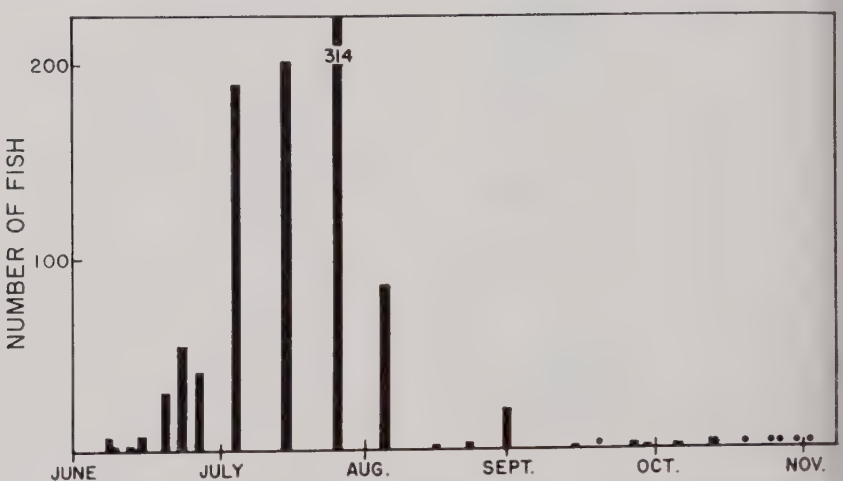

Figure 6. Seasonal frequency of alewives at depths of 5 to 50 feet at Flat Rock on Cayuga Lake, June to November, 1945. (after Webster)

by Odell (1934) who found that they left the shallow waters in October and November and did not reappear until March and April.

Netting in the winter of 1950–51 produced too few specimens to warrant inferences regarding winter habitat. The largest catch for any one net (22 fish) was taken on February 12 in a gang set off Flat Rock. Nineteen of these were taken at 95 to 125 feet with one individual being caught at the extreme outer end at 230 feet. No alewives were taken in less than 40 feet of water during the winter period.

Eaton (1928) reported that alewives were taken in Cayuga Lake at depths of 160 feet. Pritchard (1929) stated that in Lake Ontario they were taken at all depths up to 300 feet but that they were more common inshore. In the course of this study they were recorded as deep as 250 feet in the summer and fall; however, they were taken much more frequently in waters less than 140 feet in depth.

Smelt

Despite the fact that the smelt has appeared in large numbers during the spring spawning run in the tributaries of Cayuga Lake in recent years, the gill net catch was small. The catch in the summer, fall and winter periods was 76, 73, and 96, respectively, with corresponding catches per standard gang of 1.5, 2.8 and 4.2 (Table 5). The total catch amounted to 245 smelt with an average of 2.5 fish per standard gang, mostly taken in the smaller mesh sizes (Tables 2, 3 and 4).

It is not known whether selectivity of gear, relatively low abundance, or failure to sample the preferred habit adequately was responsible for the small catch. The increase in the catch per unit of effort with the progression of the seasons suggests that failure to sample the areas most

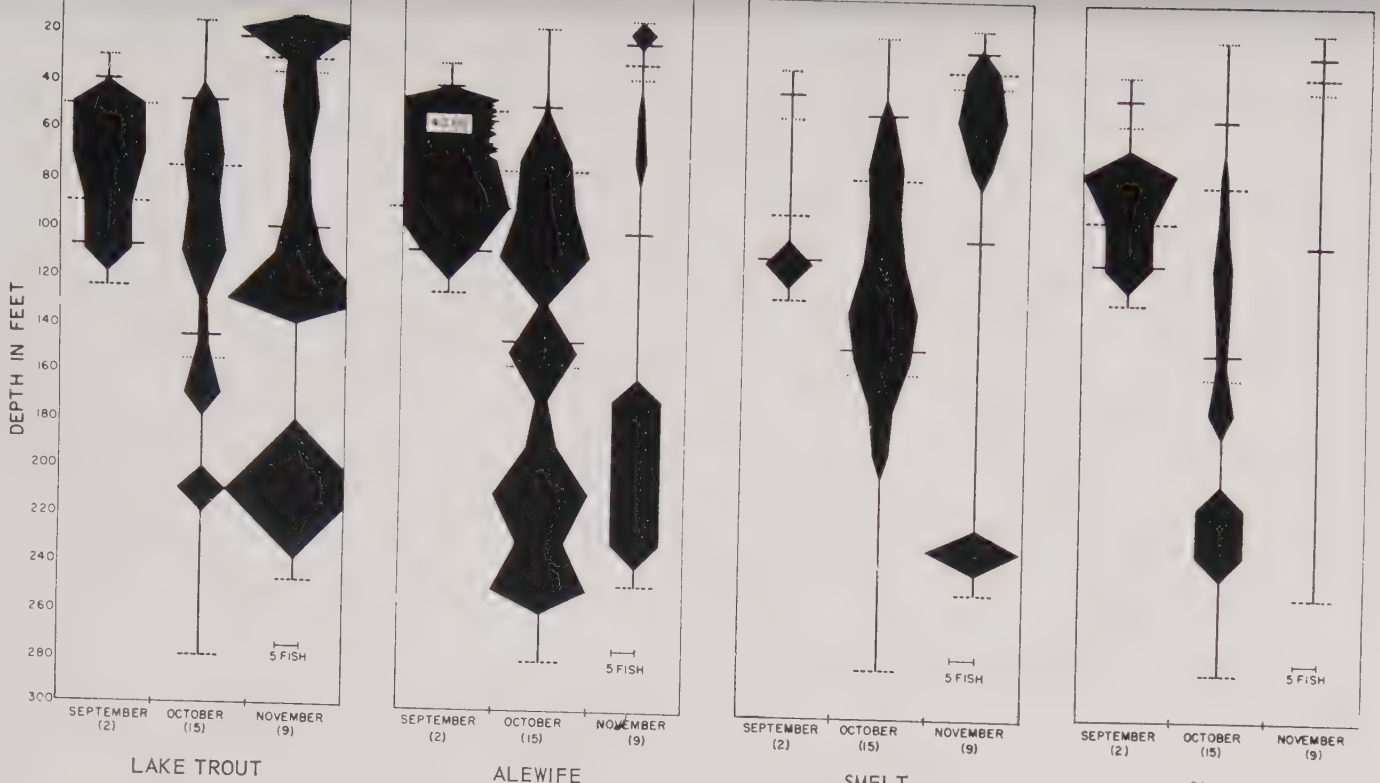

Figure 7. Relative densities of the populations of lake trout, alewives, smelt and ciscoes at various depths in Cayuga Lake during the fall as indicated by their frequency in netting samples in 1950. See Figure 2 for explanation of symbols.

frequented, especially in the summer period, was the chief factor. More intensive sampling and possibly food habits studies might give a better picture of the preferred seasonal habitat of smelt.

Horizontal Distribution Smelt appeared to be most numerous at the northern and southern ends of the lake (Sections I and V) in the summer period (Table 5). The data presented by Webster *et al.* (1959, Table 28), represent a 6-year collection period and substantiate this summer distribution for smelt in Cayuga Lake. This pattern did not coincide with that for the lake trout which were scarce at the northern and southern ends of the lake at this season.

Insufficient data were available to detect changes in fall distribution, but winter collections suggested more movement and higher concentrations in the central basin (Sections II, III and IV). It is believed that this change in distribution during winter may have been due to the onset of the breeding season.

Vertical Distribution Compared with lake trout, relatively few smelt were captured in the summer months (particularly in June and August). The greatest density for smelt in July was in the 100 to 120-foot depth interval (Figure 5). It is believed that, although the catch of smelt was light in the early part of the summer, their density at 100 to 120 feet was fairly representative. The reason for not taking fish in greater numbers was simply due to failure to sample the preferred habitat, i.e., the fish may have been more pelagic at this period. Eaton (1928) reported that smelt were found most commonly at depths of 100 feet during the summer in the Finger Lakes.

The inshore movement in September might also have been a response to water temperature, since they occur chiefly below the 55° (F.) isotherm. Greene (1930) reported that in Lake Champlain the smelt preferred 55° water and were not often found in water as warm as 60° F. He also reported that the deepest they were found in the summer was 150 feet, but that they were taken throughout the lake in gill nets at 40 feet. In Cayuga Lake, a few specimens were taken in the summer period at less than 40 feet and a very small proportion of the catch occurred between 40 and 60 feet.

In the winter period in Cayuga Lake, smelt were taken at depths of 20 to 150 feet; however, the majority occurred in the shallower depths of about 45 feet. Although this inshore movement in the late fall and winter was undoubtedly permitted by lower water temperatures, their presence inshore in the late winter coincided with the onset of the spawning season.

Cisco

Eaton (1928) stated that the cisco is indigenous to all of the Finger Lakes. In many places where they exist with the lake trout they are ar

important forage species, although they are not utilized to any appreciable extent in Cayuga Lake. There are only two records of lake trout from Cayuga Lake having ciscoes in their stomachs. One was an 18½-pound fish that had eaten an 11-inch cisco, and the other a 10.8-inch trout which contained a cisco 5.5 inches long. Just what role this species plays in the economy of the lake is not known. It is not particularly abundant and hence may be relatively unimportant.

The take of ciscoes dropped off considerably as the season progressed. The catch for the summer was 2.6 per standard gang; for fall, 0.7; and for winter, 0.3. The total catch was 156 fish with an average of 1.6 per gang (Table 5). The efficiency of the various mesh sizes is shown in Tables 2, 3 and 4. It would appear that mesh sizes of between 2 and 3 inches catch adult ciscoes best. The mean length of 132 ciscoes was 11.6 inches with the largest and smallest specimens being 15.0 and 8.5 inches, respectively.

HORIZONTAL DISTRIBUTION The horizontal distribution of ciscoes during the summer months was fairly uniform for all sections except Section V (Table 5). The high frequency value at the northern end of the lake resulted from the catch of two gangs, at Stony Point and Long Point, which took 52 fish on September 8. This concentration may possibly have been related to the spawning period. In the fall and winter periods, the catch dropped off so that no information could be gained regarding density in the various sampling sections of the lake.

VERTICAL DISTRIBUTION Ciscoes in Cayuga Lake inhabited the deep waters more consistently than lake trout, alewives or smelt, and their vertical distribution was quite stable (Figures 5 and 7). There was no marked movement from deep to shallow waters although some residents at the northern end of the lake reported having seen them in shallow water off Canoga during the fall, presumably spawning.

The majority of the fish caught during the summer period were taken at depths of 80 to 160 feet (Figure 5). Maximum density in July occurred between 120 and 160 feet (deeper than for the lake trout at this time). Peak density during August and September was at 130 feet. However, the large catch in two gangs in September in Section V affected the distribution somewhat in that several ciscoes were taken in the 80 to 100-foot depth interval. The shallowest depth at which a cisco was recorded during the summer was 48 feet in July and the deepest was about 245 feet for two specimens also taken in July.

Figure 7 shows that ciscoes were found in relatively shallow water (70 to 90 feet) in the latter part of September. Specimens were taken in deeper water in October, but none were taken in November. In the winter period, only six specimens were captured. These were taken at depths of 45 to 175 feet.

The failure to capture small, immature ciscoes in gill nets was prob-

ably a reflection of their pelagic nature during this early portion of their life span or simply the result of a lack of young or small ciscoes during the sampling period. Kennedy (1956) related that in the extremely deep northeastern end of Great Slave Lake ciscoes affect lake trout distribution. In this particular area the lake trout prey mostly on ciscoes and, as a result, are presumed to be independent of the bottom and hence generally invulnerable to capture by the commercial gill netters.

Other Species

Some data were obtained regarding the distribution of other species in Cayuga Lake, chiefly rainbow trout, smallmouth bass, yellow perch and rock bass.

Rainbow Trout Of these other species, the rainbow trout, if abundant, would probably be the most important with respect to possible interrelationships with lake trout and other deepwater forms. During the 1950–51 gill netting operations on Cayuga Lake, 14 were captured.

The catch of rainbow trout occurred in two areas, Franklin Point and Flat Rock. Eight were taken at Franklin Point and four at Flat Rock in the summer period. Another was captured at Flat Rock in the winter on January 31, 1951. The remaining two fish were taken at Willow Creek (fall) and Lake Ridge (summer). The largest rainbow trout taken was an exceptionally well-conditioned specimen, 20.2 inches in fork length and weighing 4 pounds 15 ounces.

The 14 trout captured in gill nets were taken at depths of 30 to 82 feet with an average of 50 feet. It is believed that the rainbow trout primarily frequents the intermediate depths off the bottom, with occasional foraging expeditions to the surface and bottom.

Smallmouth Bass Only 11 smallmouth bass were captured in gill nets, five late in the summer period and six in the fall. All but one were were taken in 3- and 3½-inch-mesh nets. The bass netted were fairly uniform in size, running from 9 to 12 inches in length.

It was of interest that this species was captured by gill nets (which are relatively inefficient gear for capturing bass) in much deeper water than would normally be expected. Most of the fish were taken at depths of 55 to 80 feet with 65 feet being the average. These depths exceed those at which fishermen normally fish for smallmouth bass. Encountering bass at these depths suggests that they utilize the alewife population even when the latter has left the shallow water.

Yellow Perch A total of 111 yellow perch were captured; 64 were taken in the summer period, 35 in the fall, and 12 in the winter. Tables 2 and 3 show that the 2-inch mesh size was most efficient for taking this species. Of 69 perch measured, the size range was from 4.6 to 13.0 inches and the mean length was 7.5 inches. It was noticed that the best

catches of perch invariably occurred when the 2-inch mesh in the gang was located inshore.

There was no habitat preference evident from the catch of perch throughout the lake. All of the sampling sections were about equally represented in the catch.

The greatest depth at which perch were taken in the summer and fall periods was about 70 feet with the average being about 35 feet. This held for the winter period except that two small fish (4.6 and 4.8 inches long) were taken in the south bay at Taughannock on February 13, 1951 in about 100 and 160 feet of water.

Rock Bass Thirty rock bass were captured during the 1950–51 sampling period. Most of these (23) were taken during the fall. Five were taken in the summer and two in the winter months. Rock bass were taken in all mesh sizes of the standard gangs. The mean length of 28 fish measured was 6.5 inches with a range from 3.1 to 9.6 inches.

As with the bass and perch, no particular area was indicated as being most productive. The average depth at which rock bass were captured was about 40 feet. Three specimens were taken at 80 feet and one at about 100 feet.

DISCUSSION

During the summer months (June, August and September) the greatest population density of lake trout occurred at a depth of 80 to 100 feet. These trout, however, occurred quite abundantly between 40 and 140 feet with individuals being recorded commonly to depths of 200 feet. In July, a greater density was observed in shallow water (20 to 60 feet). In the latter part of the summer, fish were not found as frequently in less than 70 feet of water. The greatest density, however, remained at 80 to 100 feet. In general, trout were captured most often during the summer in the zone between the 45° and 55° (F.) isotherms. The one notable exception was in July when fish moved inshore in 20 to 60 feet of water where 60° to 65° temperatures prevailed. The concentration of spawning alewives is believed to have been responsible for this movement. For the most part, the trout occurred more frequently at the greater depths as the isotherms dropped and summer progressed. In the fall, the depth distribution pattern became more erratic; however, there was a definite tendency for trout to move into shallower areas as the water cooled.

There was no marked depth preference detected for any size class of lake trout. Both large and small fish were found to frequent similar depths.

Little mention has been made in this paper of the horizontal distribution of lake trout. Accumulation of data for a further period of 6 years permits more valid assumptions about horizontal distribution and movement. They are based on the recovery of marked hatchery fish and tag returns for wild fish and are covered by Webster *et al.* (1959) in a more

detailed report on the Cayuga Lake trout population. Suffice to make the general observation that the distribution of trout less than 20 inches long in Cayuga Lake in the summer period was found to be fairly uniform between the five sampling sections. Further comment may be in order, however, on the definite concentration of large-sized trout observed in the Willetts-King Ferry area (Section IV) during the summer.

There is no specific evidence as to why fish congregate in this area but a habitat variation was detected in the bottom deposits in this locale which may appeal to adult lake trout. Fishermen have consistently reported sulphur springs offshore near Franklin Point. Under favorable conditions the water is said to be milky and to have a faint odor of sulphur in the vicinity of the springs. The bottom type in this area varies from that normally encountered in the deeper waters of the lake. For the most part throughout the lake, the bottom, at depths of 50 feet or more, is characterized by a very fine mud or ooze which may be red, brown, gray or black in color. However, in the area between King Ferry and Willetts, bottom samples revealed a generous portion of coarse grit-like material.[5] Several series of soundings at 200-foot intervals perpendicular to the shoreline revealed a general profile of rubble extending from 25- to 50-foot depths, then coarse grit, grit and red mud, red mud and some fine grit, and finally brown or black mud. The red mud with some grit extended into the lake to a depth of 275 feet off Franklin Point, but about 700 yards north of the point the grit was last detected at about 120 feet, with brown mud at 155 feet and black mud at 200 feet. The occurrence of grit in the mud in such situations may have resulted from subsurface currents which washed away or prevented deposition of the very fine materials.

In the wintertime netting success decreased for all species except smelt. This may have been due to changes in the behavior pattern; for example, the fish may have been more pelagic at this time, or netting operations failed to sample the areas most frequented. More likely, it may simply have been the result of less movement at extremely low water temperatures. Smelt, on the other hand, would be expected to move with the onset of their spawning time.

This matter of low winter catches was also discussed by Kennedy (1956) in his report on the commercial lake trout and whitefish fishery of Great Slave Lake. He postulated that fish obviously will not be caught

[5] Also, in this area, honeycombed rocks of various sizes, ranging from a few inches to 10 inches at their greatest diameter, were brought up in gill nets. The majority of the rocks were characterized by smooth, deep solution pits and were identified as pieces of Tully limestone, very common to this region and a product of the lowermost strata of the upper Devonian period. Immediately above this layer of Tully limestone exists an 80-foot layer of Genesee black shale. This layer of shale is rich in sulphur deposits and is very possibly responsible for the occurrence of sulphur springs in this locality. A crustal movement at some time, more pronounced in this area than elsewhere, could account for these formations being closer to the surface there.

in gill nets unless they move around and that, when water temperatures are near freezing, it seems likely that fish move less than in summer. He stated further that a winter fisherman's catch comes from within a very limited area near his nets; fish may be so inactive in winter that after those in a particular area have been removed they are not replaced by immigration for a considerable time.

Of the other deepwater species discussed, the alewife seemed to have the greatest degree of interrelationship with the lake trout. It occurred in relatively greater numbers than any other species and in all areas inhabited by lake trout. Their distribution was general or uniform throughout the lake. With respect to depth distribution, it was determined that during the summer and fall periods, when adequate samples were taken, they would be available at all times as forage species for the lake trout population. It has been established that they are the most heavily utilized forage species of the lake trout in Cayuga Lake (Webster *et al.*, 1959).

The catch of smelt in gill nets in the summer period was insignificant in comparison with the alewife catch. Smelt occurred most frequently over the flats at the northern and southern ends of the lake in the summer, but there was indication of movement in late winter, probably toward the spawning tributaries. Lake trout utilize this species in late winter and early spring when both are in relatively shallow water (Webster *et al.*, 1959).

Only during the summer period were there sufficient numbers of ciscoes captured to allow detailed analysis. Like the smelt, they were most abundant at the northern and southern ends of the lake. It appears that the cisco occupies greater depths more consistently than any of the other species discussed. Their greatest density in July and August was in water from 120 to 160 feet deep. It is felt that ciscoes are not abundant in Cayuga Lake and are relatively unimportant.

Warm-water fishes were taken in waters deeper than normally expected, providing evidence that occasionally some of these fishes go deep, probably on foraging expeditions, for at least brief periods of time.

Although no gill nets were fished entirely at depths greater than 200 feet, the evidence indicates that neither the lake trout nor other deepwater forms discussed in this paper inhabit to any appreciable extent the vast bottom area of Cayuga Lake below the 200-foot contour, even though the area is well supplied with dissolved oxygen.

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GENERAL NOTES

GERMINATION OF STAGHORN SUMAC SEEDS[1]

Philip U. Alkon Conservation Biologist
New York State Conservation Department
Donald L. Schierbaum Senior Wildlife Biologist
New York State Conservation Department

Seeds of staghorn sumac (*Rhus typhina*) will not germinate unless the hard, impervious seed coats are made permiable. According to the U. S. Forest Service (1948) dispersal of sumac seeds in the wild is accomplished almost entirely by birds or other animals. Apparently, passage through animals' digestive tracts reduces the imperviousness of the seed coats. The only artificial treatment described by the Forest Service is soaking in sulfuric acid for 60 to 80 minutes; they noted that treatment of staghorn sumac seeds for artificial germination "needs further study".

Since this plant provides ideal food and cover for cottontail rabbits, and other wildlife, an effective and practical method for establishing it by seeding could be important in habitat improvement measures. Four seed treatments were tested at the Wildlife Research Laboratory at Delmar (N. Y.) during the summer of 1960.

1. Acid: seeds were soaked in sulfuric acid for 80 minutes and then rinsed with warm water.
2. Hot water: seeds were placed in boiling water and allowed to soak for 80 minutes.
3. Scarification: seeds were run through a cement mixer containing soft-ball-sized stones for 30 minutes.
4. Surface burn: untreated seeds were planted; then the surface of the site was covered with hay which was burned.

The study site was divided into 25 plots. Each treatment (including a control) was replicated five times according to a previously designed 5 x 5 Latin square. The individual plots were 25 square feet in area.

Prior to treatment, seeds collected the previous winter were thoroughly mixed and divided into five 270-gram lots, one for each treatment. Following treatment each lot was subdivided by weight into five lots, one for each plot.

Plantings were made on July 27. Vegetation on the study site had been previously cut and plowed under. The site was harrowed and 6 yards of sand were thoroughly mixed into the surface soil. Seeds were then broadcast by hand and raked lightly into the soil.

Only two treatments, hot water and acid, proved effective (Table 1). The hot water technique was the most satisfactory in terms of number of seedlings produced as well as cost, ease and safety of application.

Germinated seedlings first became apparent in numbers about 2 weeks after planting (Figure 1), and peak production was observed on August 25 or 4 weeks after planting. Thereafter, the number of viable seedlings declined. By September 9 the number had decreased by 19.2 per cent from the peak. The decline may have represented normal thinning, since the greatest reductions took place in plots having the highest densities. Damping off accounted for the death of at least some seedlings.

Over-all germination rates were low even for seeds given the hot water and acid treatments. Measurements of a 10-gram sample indicated that approximately 20,000 seeds were sown for each treatment. The highest seedling count, 907 plants on August 25 for the plots representing the hot water treatment, indicated a germination rate of only 4.5 per cent, while the corresponding figure for the acid-treated seeds was 2.8 per cent. Actually these percentages are underestimates of germination success because new seedlings were appearing throughout the observation period, while others were dying. Thus, the seedlings counted at any one time included only those that were alive at that particular time.

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Table 1. Relative Germination of Staghorn Sumac Seeds Given Different Treatments as Indicated by Seedling Counts at Intervals after Planting

Treatment	August 11	August 19	August 25	September 2	September 9
Acid					
Number	370	555	561	527	472
Per cent	38.2	37.5	37.0	38.2	38.5
Hot water					
Number	568	880	907	814	720
Per cent	58.6	59.4	59.8	59.0	58.8
Scarification					
Number	3	8	8	8	6
Per cent	0.3	0.6	0.5	0.6	0.5
Surface burn					
Number	26	36	36	28	24
Per cent	2.7	2.4	2.4	2.0	2.0
Control					
Number	2	2	4	3	3
Per cent	0.2	0.1	0.3	0.2	0.2
Total					
Number	969	1,481	1,516	1,380	1,225
Per cent	100.0	100.0	100.0	100.0	100.0

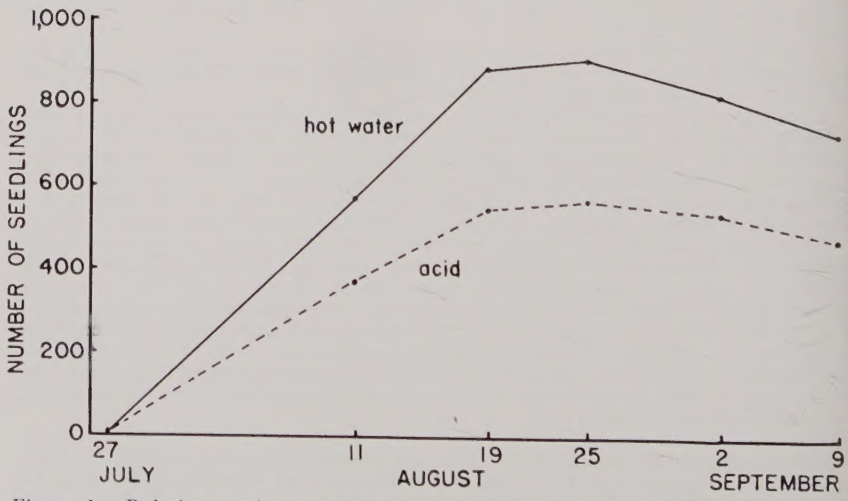

Figure 1. Relative number of staghorn sumac seedlings produced by seeds given hot water and acid treatments. All seeds planted July 27.

The apparently low germination rates may have been due to several factors. It is likely that many of the seeds were not viable to begin with. Damping off may have eliminated many of the younger plants before they were counted. Also, the relatively heavy and often wet soil on the study site was probably less than ideal for sumac since this plant is considered most successful on light, dry soils (Van Dersal, 1942; Wyman, 1956). Nevertheless, the hot water technique seems to be a promising method of treating staghorn sumac seeds to increase the rate of germination.

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